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# The Need for an Industrial Policy for long-term Growth

**Sofia Anyfantaki, Yannis Caloghirou, Konstantinos Dellis, Aikaterini Karadimitropoulou, Filippos Petroulakis**

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# The need for an industrial policy for long-term growth[1]

Sofia Anyfantaki[2], Yannis Caloghirou[3], Konstantinos Dellis[4], Aikaterini Karadimitropoulou[5], Filippos Petroulakis[6]

## ABSTRACT

We document and analyse key deficiencies of the Greek economy, with the view to providing new insights and articulate policy proposals. We consider issues which are the purview of both horizontal policies, raising productivity across sectors, and vertical policies, which allow for realignment of activity. With respect to the first dimension, we focus on two specific problem-areas of Greek industry, with high importance: skills and management practices. We also use information from a novel survey on entrepreneurship, technological developments, and regulatory change and examine structural characteristics of innovation and technology adoption of Greek firms, with a focus on the role of size, ownership structure, and global value chain participation. With respect to the second dimension, we provide an overview of Greece's export performance and analyse its sectoral comparative advantage. In an empirical study we also focus on the determinants of export sophistication. Overall, the collection of our empirical findings provides ample fodder for concrete policy proposals to increase productivity in Greek manufacturing.

Keywords: skills; management, innovation, knowledge, export sophistication.
JEL classification**:** D22; F10; J24; J50; L22; O32

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## 1. Introduction

Since experiencing one of the deepest and longest recessions among advanced economies, the Greek economy has made remarkable progress. It successfully reduced its substantial twin deficits and achieved gradual recovery until the outbreak of the COVID-19 pandemic. Despite the disruptive impact of this global shock and the emergence of new geopolitical risks, the Greek economy has demonstrated resilience. However, it still faces significant challenges that impede its long-term prospects. In critical areas, crucial for long-term growth, Greece lags its peer countries. Greece lacks a systemic "activating knowledge" dimension (European Commission's European Innovation Scoreboard 2023). To unlock substantial potential growth, it is crucial to enhance capabilities, boost the productivity of existing resources, and promote innovation (Albani and Anyfantaki, 2017).

The main objective of this study is to demonstrate the scope for industrial policy for Greece, which addresses the issue of upgrading industrial activities to usher in a new growth paradigm, going beyond wage suppression, to raise productivity, climbing up the value chain and deepening capabilities within and across functions. The outbreak of COVID-19 urges a rethinking of the role of government in not simply fixing market failures, but actively shaping markets in partnership with the business sector, and highlights the risks of over-reliance on tourism, stressing the need to urgently diversify. Although boundaries between policies are porous, we follow a two-dimensional approach consisting of horizontal policies, designed to raise productivity across sectors, and vertical policies, targeting specific industries.

In this paper, we concentrate on specific problem areas within the Greek industry. Our analysis encompasses existing established facts while also presenting new empirical findings. By harnessing international datasets and integrating novel survey data, our aim is to precisely identify deficiencies and benchmark Greece with its counterparts.

We begin by reviewing evidence on the dimensions of the skills gap in Greece to identify the scope for action, particularly in addressing mismatch. Although Greece witnessed significant increases in educational attainment, the transition from university to the labour market remains exceptionally challenging (OECD, 2020), a phenomenon likely associated with very high skills mismatch (Katsikas, 2021). The financial crisis further exacerbated the situation as many highly educated and/or skilled individuals faced unemployment or underemployment, and a significant number opted to leave the country (resulting in a "brain drain").

To explore the empirical relationship between skills mismatch and firm productivity, we use microdata from the OECD Programme for the International Assessment of Adult Competencies (PIAAC). We show that Greece has by far the highest over-skill mismatch in highly skilled ("professional") compared with all other countries in the sample. Furthermore, we examine the relative importance of over-skill mismatch in professional occupations, following Adalet McGowan and Andrews (2015), and our results corroborate previous findings that over-skilling has a negative effect on labour productivity.

We then investigate management practices in the manufacturing sector. Extensive empirical research has highlighted the significance of management practices in elucidating productivity disparities both across countries and within sectors (Scur et al., 2021). Management practices have been acknowledged as akin to a form of technology (Bloom et al., 2016) and serve as a fundamental input for innovation and the assimilation of technology (Acemoglu et al., 2007).

We utilize firm-level data on the management practices in Greek industry from the World Management Survey (WMS). Our findings reveal a significant dispersion of management practices within the country. Greek firms perform poorly in aspects related to people management, planning and oversight, as well as synergies, dialogue, and collaboration. On the other hand, they fare better in decision-making tasks, which may be influenced by a single individual. Additionally, we discover that Greece exhibits the largest disparity in management practices between domestic firms and foreign multinationals operating in the country. We further establish a positive relationship between management quality and firm performance in terms of productivity for Greek manufacturing firms.

To gain insights into the structural characteristics of firms' innovation activities and digital adoption, we also analyse data from a unique survey conducted in 2019 by the Laboratory of Industrial and Energy Economics of the National Technical University of Athens (LIEE/NTUA), supported by the Hellenic Federation of Enterprises (SEV). We examine the role of firm size and family ownership, and global value chain (GVC) participation. While firm size is indeed a significant factor influencing product innovation, we find, surprisingly, that family firms do not exhibit lower performance in terms of innovation, despite being less likely to have an in-house research and development (R&D) department. Regarding digital technology adoption, we find that family firms are significantly less likely to adopt practices associated with the digital transformation process. Lastly, we observe a positive association between participation in GVCs and both innovation and the adoption of digital technologies.

As a second step, we focus on Greece's export performance. Although Greece has shown notable signs of improvement, concerns remain regarding the competitiveness of Greek products, their inadequate differentiation and penetration into foreign markets. It is not just the quantity of exports that matters; the nature of exports is equally significant (Hausmann et al., 2007). We identify the product categories where Greece enjoys relative comparative advantage (using the RCA index), and categorise them in terms of technological intensity using Lall (2000). We combine this with the PRODY and EXPY index (Hausmann et al., 2007) to study the productivity level of Greek exports and Greece's export sophistication and show that Greece must increase the technological sophistication of its exports. We then use the data visualization tool of Atlas of Economic complexity based on the notion of "product space" of Hidalgo and Hausman (2009), to examine where in the high-value product space Greece can more easily transition to. We see that Greece mainly exports goods characterized by low complexity underscoring the potential for great improvement in diversifying by focusing on a Parsimonious Industrial Policy. Hausmann et. al. (2008) explain that a parsimonious strategy for industrial policy focuses on existing economic activities, and proposes mechanisms to, on the one hand, identify and, on the other hand, remove, any barriers facing these activities. The idea is that an improved provision of public inputs to existing activities could lead to higher productivity and quality for existing activities, as well as an increased probability that 'nearby' products – that is products requiring capabilities similar to the ones that already exist in the country – will emerge.

Overall, public policy faces many challenges due to the need for public inputs. Here, we, on the one hand, summarize some existing guidelines that can help tackle the information, incentives, and resource mobilization problems associated with the best possible provision of public inputs, and, on the other hand, provide a list of strategic new products, that is products that could potentially have existed with this alternative provision of public inputs.

We emphasise that a Parsimonious Industrial Policy for Greece is suitable in particular for manufacturing and other knowledge-intensive sectors. The parsimonious approach, with its focus on existing activities and nearby products, is in general useful for low- and middle-income countries, which are further away from technologically advanced products. Countries at the lower end of the high-income spectrum, such as Greece, need to advance across a range of sectors to achieve long-term and resilient growth. In fact, one of the major concerns of the Greek economy is its excessive reliance on tourism and transportation services, as well as non-tradable activities, and one of the purposes of this project is to detail strategies to advance away from this model. However, given the relatively small size and sophistication of manufacturing and knowledge-intensive sector, we believe that the parsimonious approach for these activities is useful at the current juncture.

In a separate empirical application, we study the determinants of export sophistication and show that there is a strong positive relationship between innovation, digitalisation, skills and export sophistication.

The results corroborate the arguments of Hausman at el. (2007), showing that countries performing better tend to have a higher proportion of high-quality goods in their exports. This implies that the benefits of globalization are primarily realized by countries with a significant level of technological sophistication in their export mix. Consequently, it is crucial for a country to focus on sectors that exhibit significant externalities due to agglomeration (such as knowledge spillovers, input-output linkages, and lower transportation costs) in order to take advantage of the gains from trade.

Overall, our findings give vigour to the argument in favour of an industrial policy. Horizontal reforms that enhance innovation capacity, functional innovation systems and skills indispensable for the Fourth Industrial Revolution (4IR) can spur growth beyond what is expected from the level of GDP per capita. Moreover, vertical policies targeting the increased participation of manufacturing in total economic activity and harnessing digital transformation also appear to bolster export sophistication.

The structure of the paper is as follows: Section 2 provides an in-depth analysis of skills challenges in Greece, including a review of skills indicators, as well as an analysis of the empirical relationship between skills mismatch and firm productivity. Section 3 considers management practices in Greek firms, benchmarks their performance and identifies the relationship between management quality and productivity. Section 4 presents the findings from the LIEE/NTUA survey. Section 5 provides some overview of Greece's export performance, analyses sectoral comparative advantage, and studies the determinants of export sophistication. Section 6 concludes.

## 2. The alignment of skills with job requirements in Greece

EU Member States, including Greece, have sought to increase skills supply, notably through raising educational attainment. Greece has indeed experienced an increase in tertiary education attainment over the last decade: in 2020, 44.2% of adults aged 25-34 had completed tertiary education, against 32.7% in 2010 (OECD, 2020). Despite the growth in educational attainment, concerns persist regarding the alignment of the education and training system with labour market needs. University education is typically seen as not equipping graduates with the cutting-edge skills demanded by the labour market, leading to the perverse co-existence of a higher share of university graduates and one of the lowest overall scores in the European Skills Index (ESI) survey of 2022.[7] This low ranking is attributed to low scores in each of the three ESI pillars, pointing to a relatively weak skills system in Greece on multiple fronts.

The Greek economy's low skill level poses challenges for employers in filling vacancies, creating a significant barrier to potential growth. However, this mismatch between skill supply and demand can also extend to existing employment relationships. On-the-job mismatch occurs when workers' skills and qualifications do

[7] The European Skills Index (ESI) is Cedefop's composite indicator measuring the performance of EU skills systems. The ESI measures countries' "distance to the ideal" performance. The ESI consists of three pillars: skills development; activation; and matching.

not align with the requirements of their job. Efficiently matching workers to suitable positions is vital for productivity. Workers vary in their skill levels and relative productivity across different tasks, resulting in differences in comparative advantages (Acemoglu and Autor, 2011). To enhance allocative efficiency and increase productivity, an effective labour market should facilitate the movement of workers with different skill levels across jobs. This becomes particularly crucial when the overall supply of skills is limited, as is the case in Greece. Henceforth, in this study, we will specifically refer to this type of mismatch as labour market mismatch.

### 2.1 Skills mismatch and labour productivity

In line with theoretical predictions, mismatch has been shown to be significantly negatively related to productivity. Adalet McGowan and Andrews (2015) argue that while hiring an over-skilled worker may be beneficial to a firm, it may have negative aggregate consequences if skilled labour is trapped in unproductive firms. Mismatch can also impact average within-firm growth, since not only is the productivity of the marginal worker higher in more productive firms, but these firms can also grow faster if resources are reallocated towards them (Decker et al., 2017). If firms were homogeneous, misallocation would matter much less.[8] However, firms with radically different productivities co-exist in the market (Syverson, 2004). In a well-functioning economy, resources flow to more productive uses, resulting in productivity gains from allocative efficiency, a key factor explaining differences in aggregate productivity across countries (Bartelsman et al., 2013; Hsieh and Klenow, 2009).

The literature typically focuses on separating over- and under-skilling; we dig deeper and examine how mismatch differs across occupations, distinguishing between highly skilled ("professional") jobs and all other jobs.[9] The survey asked workers whether they feel they "*have the skills to cope with more demanding duties than those they are required to perform in their current job*" and whether they feel they *"need further training in order to cope well with their present duties"*. Over-skilled

[8] In particular, if firms were homogeneous within a sector, then only sectoral misallocation would matter.

[9] The professional category includes occupations in ISCO occupational groups 1 to 3, and we group all other categories together. The sample size is not sufficient for a finer classification.

(under-skilled) workers are those whose proficiency score is higher (lower) than that corresponding to the 95$^{th}$ (5$^{th}$) percentile of self-reported well-matched workers —workers who neither feel they have the skills to perform a more demanding job nor feel they need further training in order to be able to perform their current jobs satisfactorily— in their country and occupation.[10] Literacy proficiency is our proxy for skills, per common practice.

We first confirm what is well-known; Greece exhibits the highest levels of over-skill mismatch, with approximately 28% of workers deemed over-skilled. On the other hand, around 7% of workers are considered under-skilled, compared to the OECD average of 3.8%. More importantly, Greece has by far the highest professional over-skill mismatch compared with all other countries in the sample (see Chart 1). Most surprisingly, while in virtually all countries over-skill mismatch is much lower for professional occupations than for lower-skilled jobs, the opposite holds for Greece. Even for lower-skilled jobs, over-skill mismatch in Greece is high compared with other EU countries. Similar results are obtained when using skills mismatch in numeracy and controlling for sector and firm effects.[11]

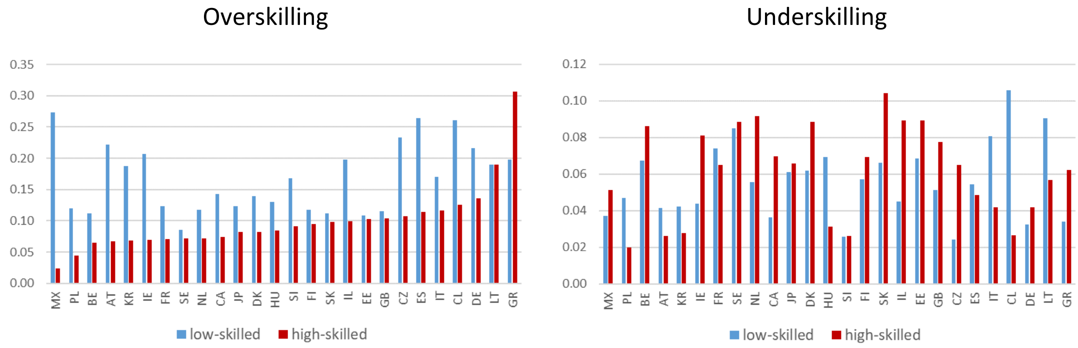
We now turn to examining the importance of over-skill mismatch in professional occupations relative to others. Professional jobs are knowledge-intensive and combine high levels of on-the-job learning and match-specific human capital (i.e., marginal productivity of workers can vary widely across firms, due to the various complementarities involved in these jobs). Moreover, if the supply of professional skills is lower relative to other skills, then search costs for finding or replacing workers for these positions will be higher than for positions requiring less formal training. Skills shortages may also be more binding for highly skilled occupations. While the importance of human capital in economic growth is well-founded, the importance of its allocation has only recently been recognised. Hsieh et al. (2019) showed that removing entry barriers in high-skilled occupations in the US resulted in higher per

[10]Mismatch has also been measured using qualifications, or field of study (McGuinness, 2006; Leuven and Oosterbeek, 2011). Over-skilling is overall considered a more accurate measure of mismatch compared to over-education (McGuinness and Wooden, 2009), but Greece scores low across all metrics.

[11]There is a concern that the high over-skilling observed in Greece may simply reflect classification noise. This is because for Greece the thresholds used to classify the appropriate skill levels for each position are determined using a small number of individuals. However, Greece has the largest dispersion in literacy scores out of all countries in the sample. This implies that applying higher thresholds for over-skilling (e.g., those that are used for Spain or Italy), Greece would still have high values of mismatch in professional jobs.

capita output by 20-40% through improved talent allocation.

**Chart 1: Skills mismatch for high- and low-skilled occupations (% of employment)**




Source: OECD, Survey of Adult Skills (PIAAC).

Notes: Over-skilled workers are those whose proficiency score is higher than that corresponding to the 95th percentile of self-reported well-matched workers, i.e., workers who neither feel they have the skills to perform a more demanding job nor feel the need of further training to be able to perform their current jobs satisfactorily, in their country and occupation. Under-skilled workers are those whose proficiency score is lower than that corresponding to the 5th percentile of self-reported well-matched workers in their country and occupation. High, medium, and low skilled occupations are ISCO occupational groups 1 to 3, 4 to 8 and 9 respectively.

We follow Adalet McGowan and Andrews (2015) and use the Olley and Pakes (1996) method to split aggregate productivity in each sector into a within-firm component and an allocative efficiency component. Specifically, aggregate sectoral productivity is given by:

$$P_j = \sum_{i \in j} \theta_i P_i = \underline{P_j} + \sum_{i \in j} \left(\theta_i - \underline{\theta_j}\right)\left(P_i - \underline{P_j}\right) \qquad (1)$$

where $P_j$ is the weighted sum of productivity of all firms in sector $j$, the within-firm component $\underline{P_j}$ is the (unweighted) average firm productivity in the sector, and the weight $\theta_i$ is given by the employment share of firm *i* in the sector. The final term is the allocative efficiency component, given by the covariance between relative firm size and relative productivity. If more productive firms are larger, then this is positive and indicates that resources flow to their more productive uses.

We use aggregated microdata from PIAAC and sectoral labour productivity indicators, constructed from firm-level Orbis data.[12] Our sample includes 17 countries: Austria, Belgium, Germany, Denmark, Estonia, Spain, Finland, France, United Kingdom, Greece, Hungary, Italy, Japan, Korea, Latvia, Sweden and Slovenia. We use data for nine sectors: manufacturing; utilities; construction; wholesale and retail trade; transportation and storage; accommodation and food service activities; information and communication; professional, scientific and technical activities; administrative and support service activities.

We estimate regressions of the following form to explore the link between labour productivity and mismatch:

$$productivity_{j,c}^{k} = \alpha + \beta mismatch_{j,c}^{k} + \delta_j + \varepsilon_{j,c} \qquad (2)$$

The dependent variable is a labour productivity measure in country $c$ and sector $j$ and the regressor is skills mismatch. We also include a sector dummy $\delta_j$ to control for structural time-invariant differences in productivity and mismatch.

We regress the three ($k = 1,2,3$) productivity measures (aggregate sectoral, allocative efficiency and average firm) on under- and over-skill mismatch indicators at the sectoral level. Results are shown in Table 1, Panel A. In Column (1), the dependent variable is aggregate sectoral productivity. The coefficient of over-skilling is negative and highly significant; it is also negative for under-skilling, although not significant. The economic magnitude of the relationship is sizeable: a one standard deviation increase in over-skilling, at the expense of well-matched workers (the omitted category), reduces weighted sectoral productivity by almost 10%. Column (2) shows results for aggregate sectoral productivity on the shares of over-skilled by occupation type (professional and other). We see that the coefficients for both occupation types are high and negative, although only the one for non-professional occupations is significant (at the 10% level). Note, however, that the variables are jointly highly significant, as these measures are highly correlated. As such, in Panel B we also estimate the model for each occupation type, and we see that both are highly significant. Columns (3)-(4) repeat the analysis for allocative efficiency, and (5)-(6) for

[12] The first wave of the PIAAC was run from 2011 to 2018. The Greek wave was conducted in 2015. All measures are averaged for each sector across 2009-13 to improve reliability. To improve on the representativeness of Orbis, we construct resampling weights from the OECD Structural and Demographic Business Statistics (SDBS) database.

average firm productivity. The coefficients for over-skilling are negative, but only significant for average firm productivity. Since the combined effect is highly significant, this is most likely due to low power.[13] Overall, the results corroborate the findings of Adalet McGowan and Andrews (2015): over-skilling has a negative effect on productivity.

**Table 1: Productivity and skills mismatch**

| **Panel A Joint regressions** | | | | | | |
|---|---|---|---|---|---|---|
| | Aggregate sectoral productivity | | Allocative efficiency | | Average firm productivity | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Under-skilled | -1.750<br>(-1.49) | | 0.206<br>(-0.64) | | -1.956<br>(1.64) | |
| Over-skilled | -1.521***<br>(-3.52) | | -0.553<br>(-1.55) | | -0.968*<br>(-1.77) | |
| Over-skilled professional | | -0.646<br>(1.54) | | -0.142<br>(0.67) | | -0.504<br>(-1.03) |
| Over-skilled other | | -0.780*<br>(-1.78) | | -0.535<br>(-1.50) | | -0.245<br>(-0.40) |
| Observations | 163 | 146 | 163 | 146 | 163 | 146 |
| R-squared | 0.667 | 0.589 | 0.501 | 0.522 | 0.462 | 0.368 |
| **Panel B Separate regressions for each occupation type, over-skilled** | | | | | | |
| Over-skilled professional | -0.874***<br>(-2.31) | | -0.298<br>(-1.54) | | -0.576<br>(-1.30) | |
| Over-skilled other | | -1.052*<br>(2.61) | | -0.595*<br>(1.85) | | -0.457<br>(-0.81) |
| Observations | 146 | 146 | 146 | 146 | 146 | 146 |
| R-squared | 0.584 | 0.584 | 0.510 | 0.521 | 0.368 | 0.364 |

Sources: OECD Survey of Adult Skills (PIACC) and Orbis.
Notes: Each column corresponds to a regression of the respective productivity measure on covariates. Over- and under-skilled workers are defined as in the text. Professional occupations are ISCO occupational groups 1 to 3. The estimation method is OLS with industry fixed effects.
Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

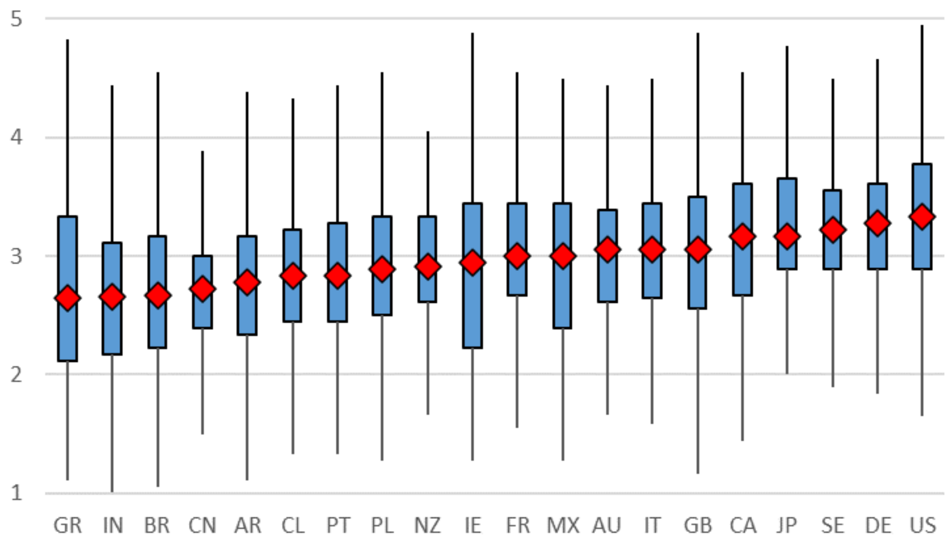
[13] Given the small sample size, we carried out a number of robustness checks. We experimented with removing large residuals and ran several robust regression alternatives (quantile regression, M/MM and S estimators using the *robreg* routine in Stata). By and large, the results hold under these checks. The results are also virtually unchanged across specifications if we control for sector concentration with the HHI index.

## 3. Management practices

### 3.1 Greece in an international context

Though long ignored in the economics literature, management has risen as a key driver of growth. In their seminal paper, Bloom and Van Reenen (2007) found that higher management scores are positively and significantly associated with productivity and various aspects of firm performance. Further work bolstered these findings and highlighted other benefits of good management, such as better work-life balance and better facilities for workers (Bloom et al., 2009), and higher energy efficiency (Bloom et al., 2010)).

**Chart 2: Management scores across countries (index from 1 to 5)**




Source: World Management Survey (WMS).
Notes: Management scores, from 1 (worst practice) to 5 (best practice). Averages are calculated across all firms within each country. The red diamonds denote the mean, the blue bars denote the interquartile range, and the black lines denote the 95% range.

Chart 2 shows average management scores across advanced economies in the WMS, a large, internationally comparable management practices dataset of randomly sampled, medium-sized manufacturing firms (Bloom and Van Reenen, 2007).[14] Greece scores last among other OECD and EU countries on average, with pronounced heterogeneity across firms. The combination of high dispersion with a low average

[14] The survey was conducted across multiple waves for each country, from 2007 to 2014. The Greek wave was run in 2014.

score suggests little diffusion of good practices from leaders to laggards. The dispersion of management practices bears a clear similarity to the dispersion of productivity. A rich literature has documented that the dispersion of productivity is indicative of low resource reallocation and technology diffusion, and a key factor behind cross-country differences in productivity (Andrews et al., 2018; Decker et al., 2020). Bloom et al. (2019) show that differences in management practices in the US account for a similar share of the variation in productivity as ICT, human capital and R&D. Indeed, Greece has been shown to have one of the largest dispersions in productivity in Europe (Gorodnichenko et al., 2018), which is suggestive evidence of the importance of management.

Similar conclusions are drawn even if we separate overall management score into its broad categories: lean operations; monitoring; target-setting; and talent management. Greece is consistently near the bottom of the distribution across all four categories. Table 2 shows the categories where Greece has the best and the worst performance, relative to the average. All five of the worst performing categories are broadly related to monitoring and talent management. Greek firms are lacking in performance tracking, clarity and comparability of goals, as well as process documentation, through which these goals can be achieved; they also fail in developing talent and promoting high performers. Managers seem unable to set realistic goals and employ clear performance metrics, which can result in an inability to reward and develop talent. On the other hand, Greek firms appear to perform at par with firms in other countries in the scope and appropriateness of lean manufacturing techniques. They also score close to the overall average in talent retention and in creating a distinctive employee value proposition (employer attractiveness).

The above findings point to an interesting pattern: Greek firms do worst in issues requiring people management, planning and oversight, or requiring synergies, dialogue, and collaboration. They do best in issues requiring decision-making, possibly by a single individual. These are consistent with low levels of trust[15] between firms and workers, and could correspondingly signal little attachment to the job, low

[15] Comparable cross-country data (European Social Survey), as tabulated by Bloom et al. (2012), place Greece at the lower end of European countries when it comes to trust.

accumulation of human capital, and eventually low productivity and wage growth. This can also have considerable consequences for the viability of small firms when, for example, the founder retires, and the succeeding generation shows weak corporate governance and lower managerial quality.

**Table 2: Greek firm's scores compared with firms in other advanced economies**

| Worst performer | | Best performer | |
|---|---|---|---|
| Category | Standardised difference from other advanced economies' average | Category | Standardised difference from other advanced economies' average |
| Performance tracking | -0.5869 | Introduction lean (modern) techniques | -0.0029 |
| Developing talent | -0.5261 | Retaining talent | -0.0101 |
| Clarity of goals and measurement | -0.4574 | Rationale for introducing lean (modern) techniques | -0.0186 |
| Process documentation and continuous improvement | -0.4219 | Creating a distinctive employee value proposition | -0.0393 |

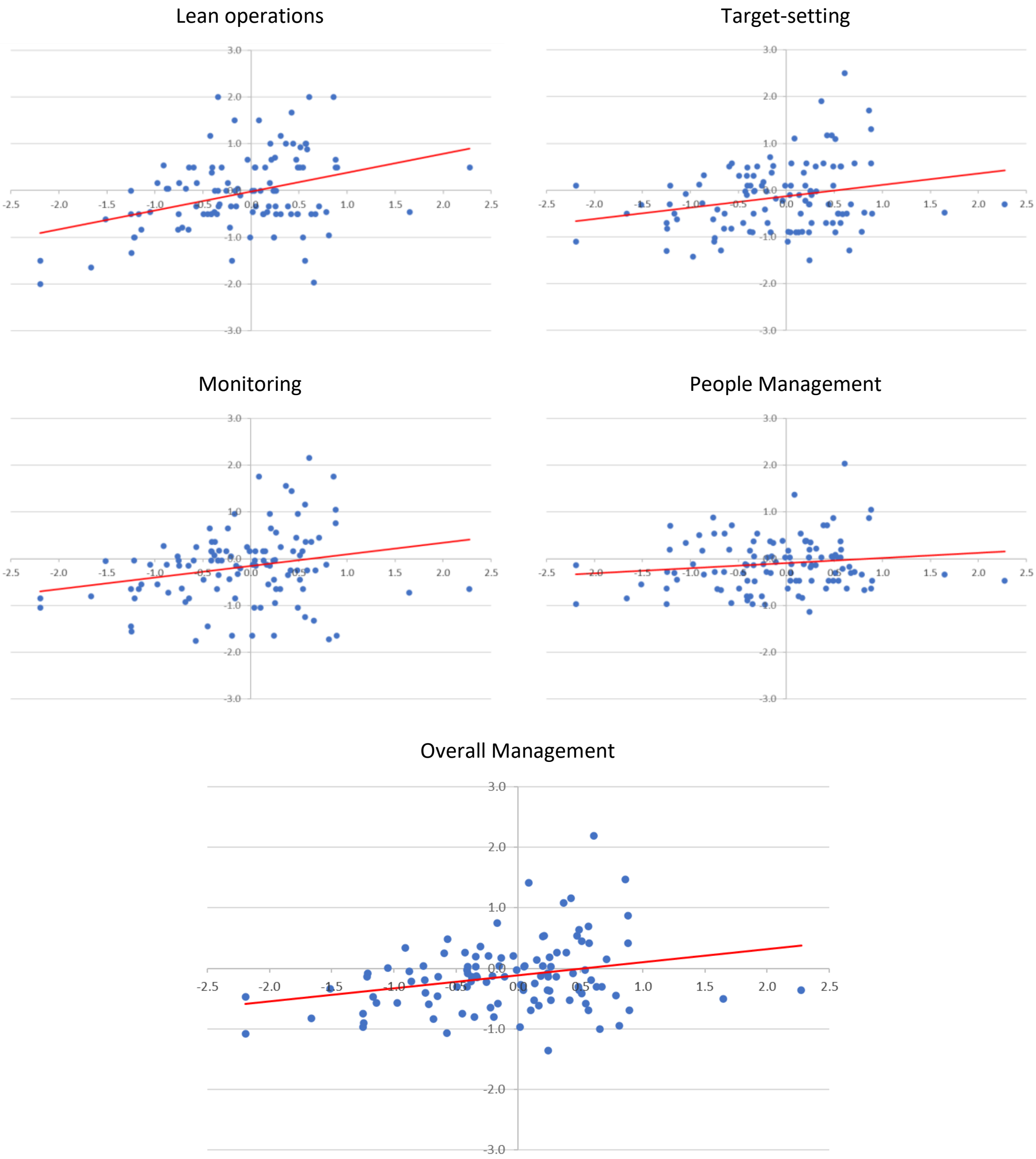
Source: World Management Survey (WMS).

### 3.2 Management practices and labour productivity

While clearly establishing the causal effect of management on productivity is not possible (Bloom and Van Reenen, 2010), examining the association between measures of management and productivity is important in determining the extent to which management practices are economically meaningful. To examine the association between management and productivity, we merge WMS data for Greece with 2017 Orbis financial data. This yields a dataset of 282 unique firm observations, of which 235 are from the 2014 wave of the WMS and the rest is from the 2006 wave.

We compute labour productivity as the natural logarithm of operating revenue divided by the number of employees. In Chart 3, we plot productivity against management scores, controlling for an industry dummy variable, dummies for firm age (using three age classes), size, multinational ownership and exporting status. The full results are presented in Appendix Table A1. Across all measures, we see that better-managed firms are more productive. For the aggregate score, the coefficient suggests that firms with a one standard deviation higher average management score have about 15 log points higher labour productivity, a sizeable difference.

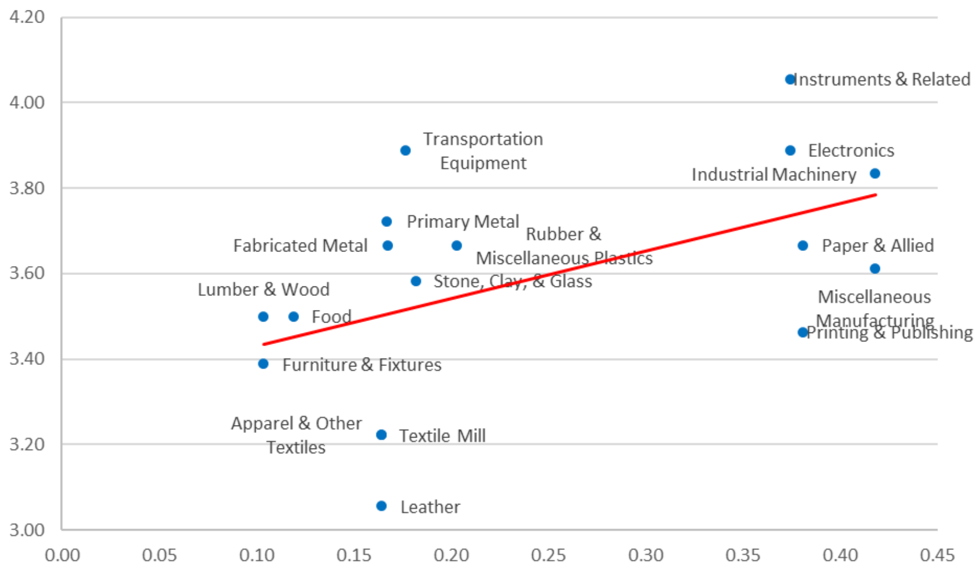
**Chart 3: Management scores and labour productivity**




Source: World Management Survey (WMS) and Orbis.
Notes: The charts show plots of management scores again labour productivity. Overall management scores include all questions and sub-indices of the questions covering each of the portions of the questionnaire (lean operations, monitoring, target-setting and people management). A full set of the questions can be found on [www.worldmanagementsurvey.com](http://www.worldmanagementsurvey.com). Labour productivity is defined as the natural logarithm of operating revenue divided by the number of employees.

The above findings are particularly troubling given the state of Greek industry. Poor management may imply a lack of appropriate structure to take advantage of existing human capital, an inability to appreciate the benefits from the adoption of new technologies, techniques, and processes, as well as a lower innovation potential. As such, it may be more of a burden in ICT-intensive sectors, given that ICT capital requires a more complex set of inputs beyond just machines and equipment (Bresnahan et al., 2002). Unsurprisingly, ICT-intensive sectors have substantially higher management scores in the WMS (Chart 4).[16] The literature has pointed out that the inability of Southern European firms to exploit ICT is an important factor behind lacklustre growth over the past two decades (Pellegrino and Zingales, 2017; Schivardi and Schmitz, 2020).

**Chart 4: Overall Management Score and ICT-intensity**




Source: WMS and KLEMS

## 4. Innovation and technology adoption

Innovation drives long-term growth, and countries need a long-term national

[16] Our definition of ICT-intensity is the sectoral share of ICT and Software expenditure out of total investment in the United States (from KLEMS), the frontier global economy, averaged over 2010-2015. The difference in aggregate management scores between high and low ICT-intensity sectors (above and below median) is over one standard deviation, on average. We obtain very similar results using the indicators of Gordon and Sayed (2020).

strategy involving the implementation of an effective innovation system, promoting interaction among stakeholders and networking between knowledge creators and those willing to promote and commercialize research and technical ideas (Hansen and Birkinshaw, 2007). At the same time, a focal point for the recovery of the Greek economy is the digitalisation of private enterprises and the public sector (Bai et al., 2021). However, Greek firms lag in the adoption of almost all facets of digitalisation (European Commission Digital Transformation Scoreboard 2019) and stand at the bottom end of the distribution in all key metrics concerning digital transformation, maturity and skills (Deloitte and SEV Digital Maturity Index 2020).

Against this background, this section examines structural characteristics of (i) innovative versus non-innovative firms, and (ii) firms in the forefront of digital technologies. We focus on the role of size, family ownership, and GVC participation since these appear to play an important role in firms' innovation behaviour. Greece has one of the largest shares of SMEs within the EU and most of them are family businesses. Hence, given that firm size is strongly related with innovation (Hall et al., 2009; Coronado et al., 2008) and given that it is also generally accepted that family involvement in ownership affects firm innovation behaviour (Carnes and Ireland, 2013; Matzler et al., 2015), it makes sense to look further at these two characteristics. Moreover, according to more recent OECD data, Greek enterprises appear not to have established significant forward and backward linkages within the globalised production systems, which could hinder their technological transformation. The causal direction of this association is unclear. Technological sophistication is a necessary condition for GVC participation, as synchronizing/harmonising production and organisational practices is easier in technologically advanced firms. On the other hand, knowledge spillovers along the value chain may expose local firms to good practices, facilitating technology adoption (Antràs, 2020; Coe and Helpman 1995).

We focus our analysis on the 2019 LIEE/NTUA Survey, which provides extensive information on innovation activity, technology adoption and GVC participation, inter alia, for a representative sample of manufacturing firms in Greece. The survey sample includes 1,014 firms: 22% are micro enterprises (below 10 employees), 57.2% are small (10-49 employees), 11.3% are medium-sized (50-99 employees) and 9.5% are large (100+ employees). Family firms account for 63% of the sample, with no pronounced deviation across firm sizes.

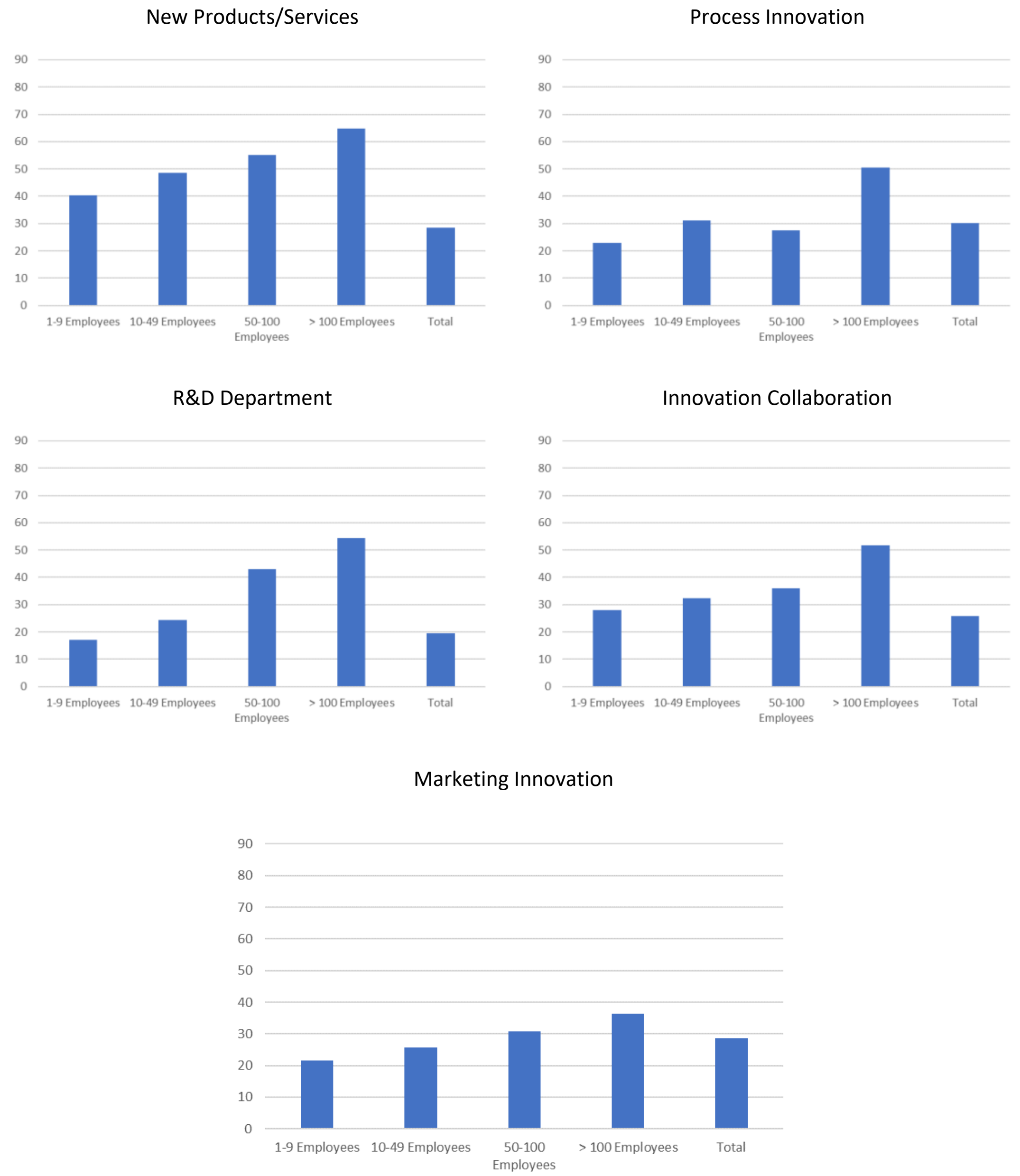
We first summarise some responses concerning innovation activity (Chart 5). About half of the firms engage in product innovation, 26% engage in organisational innovation (including marketing) and 31% have introduced process innovation. Strikingly, over one in three firms (38%) do not report any innovation activity (similar to results of the Eurostat Community Innovation Survey, CIS). Moreover, 33% of firms in the sample collaborate for activities associated with R&D and innovation. This is much higher than the 19% reported in the CIS, but broadly in line with the European Innovation Survey, in which collaboration among innovative firms is considered as a strong attribute in the case of Greece. Finally, 27% of firms in our sample report to have established an in-house R&D department.

Having said that, Chart 5 underlines the heterogeneity in innovation activity across firm sizes in the sample. Just two out of five micro firms report product innovations, whereas the respective share in large enterprises is 64%. Process and organisational innovations show similar patterns across firm sizes (in line with CIS). Perhaps not surprisingly, only 17% of micro and 25% of small firms host an R&D department, whereas more than half of the large firms do so. The differences in innovation activity by firm are statistically significant for all five variables.[17]

Many scholars have argued that small firms are the engines of technological change and innovative activity, at least in certain industries (Acs and Audretsch, 1988; 1990). Moreover, according to the European Commission's European Innovation Scoreboard 2023, product and process innovations are strong areas for Greece, despite a modest overall innovation performance. Interestingly, there are no pronounced differences between family and non-family firms in any of the three innovation categories. On the other hand, there is heterogeneity across size and family ownership concerning the establishment of an R&D department. Family ownership plays a role even within size-cluster, and this is only reversed for large firms, with more than half of large firms reporting to have an R&D department, irrespective of ownership type.

[17] Wilks and Lawley-Hotelling multivariate means test indicate statistically significant difference in means across size groups at the 1% level for all variables except Marketing Innovation (5%).

## Chart 5: Innovation activity of Greek manufacturing firms (% of respondents)



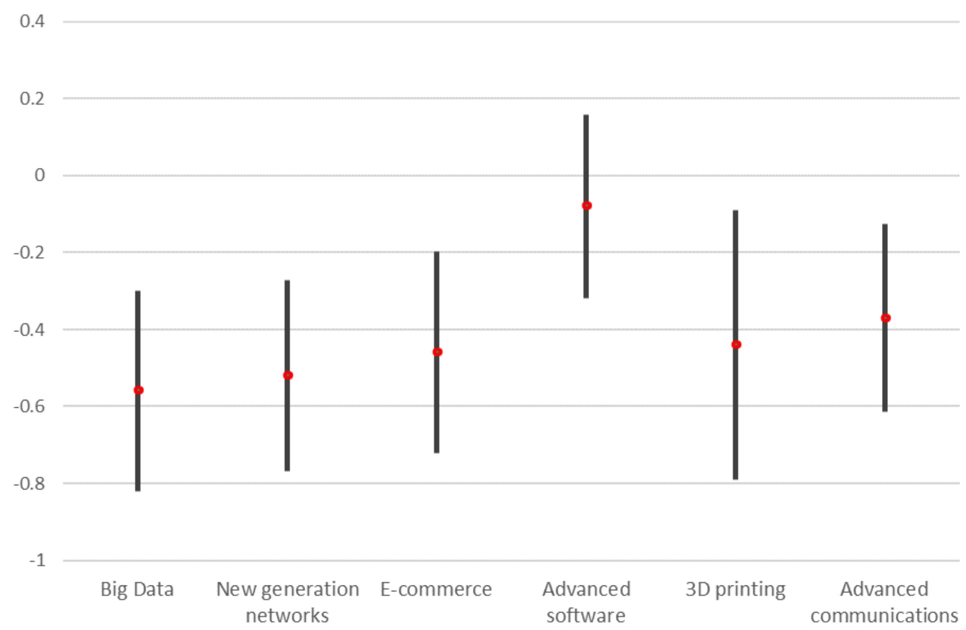

Source: LIEE and Orbis.
Note: The relevant questions are: (i) Does your firm have an R&D department? (ii) Has your firm introduced new products or services over the past two years? (iii) Has your firm introduced innovations about production processes or routines? (iv) Has your firm collaborated with other firms/organisations for innovation over the past two years? (v) Has your firm introduced innovations referring to organization, marketing, or sales over the past two years

**Chart 6: Adoption of digital technologies by Greek manufacturing firms (% of respondents)**


Sources: LIEE and authors' calculations.
Notes: The charts show the percentage of respondents in each category.

As for digital transformation, Chart 6 reveals that a very small share of firms has adopted cutting-edge digital technologies: Greek manufacturing firms perform poorly in the usage of Big Data and data analytics, and the introduction of new business models for online operations (e-commerce and participative platforms). Weak performance is pronounced in 3D printing, as over 80% have not used that technology at all. However, firms perform somewhat better regarding advanced software for organising production (CRM, ERP, CAD/CAM), access to new generation networks, such as cloud services, and use of advanced communication systems (einvoicing, digital procurement, blockchain). Overall, at least half of the firms respond *"do not use at all"* or *"do not use nearly at all"* in all six questions regarding the adoption of digital technologies.

**Chart 7: Marginal effect of family firm on the adoption of digital technologies**




Sources: LIEE and authors' own calculations.
Note: The coefficients shown are average marginal effect. The lines denote 95% confidence intervals.

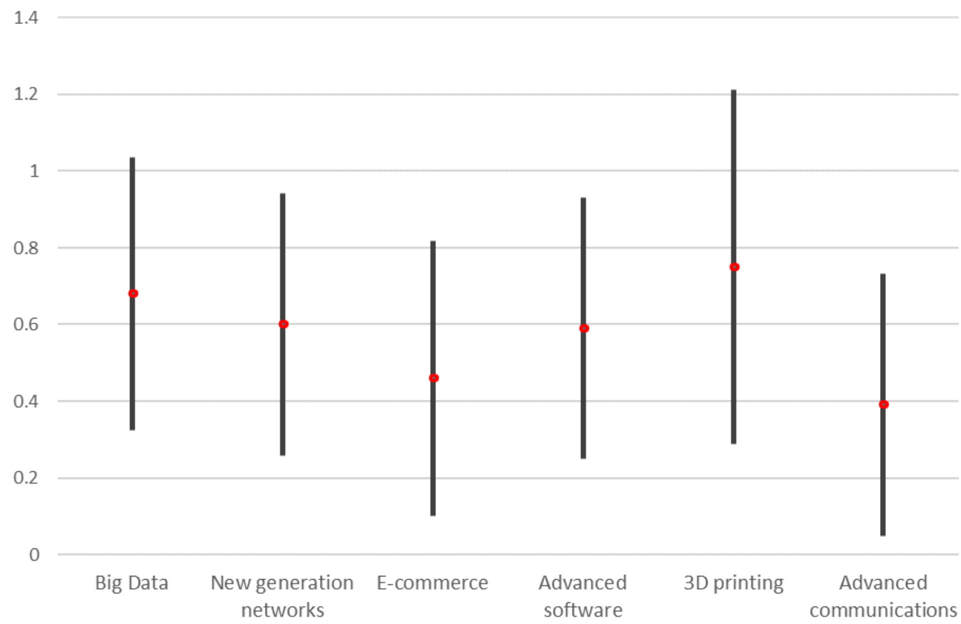
To examine whether family ownership is associated with technology adoption, we estimate an ordered logit regression, controlling for GVC participation, R&D collaboration, and firm size. Chart 7 depicts the average marginal effect of family ownership on the adoption of digital technologies (Table A2 in the Appendix presents the full results). There is a significant negative relationship between being a family firm and adoption of digital technologies, as measured by five out of the six relevant questions. The only exception is advanced software to organise production, which however is not a new technology compared with, for example, Big Data or 3D printing. On the other hand, a micro enterprise is 13 percentage points less likely to report no e-commerce services if it is family-owned, relative to other micro enterprises.

Smaller size and family ownership are also negatively associated with the 4IR preparedness.[18] Specifically, 6% of family firms respond that they have already reaped

[18] The relevant question from the survey is: How would you characterize your business in terms of following and participating in the developments of the "4th Industrial Revolution"?

the full potential of the 4IR compared with 23.5% of non-family enterprises. A quarter of firms note the lack of financial support as an impeding factor, primarily for small firms (40% compared with 13% for large firms) and family firms (36%). SMEs typically do not have enough financial and human resources for in-house innovation activities (Dufour and Son, 2015). Surprisingly, only one in three firms underscores the lack of skills as a minor or negligible obstacle.

**Chart 8: Marginal effect of GVC participation on the adoption of digital technologies**




Sources: LIEE and authors' own calculations.
Note: The dots show averages marginal effects. The lines denote 95% confidence intervals.

The slow and limited transmission of knowledge identified in Greek manufacturing can be partly attributed to the sparse participation in GVCs. Participation in GVCs is associated with enhanced innovation performance: two out of three firms participating in GVCs report product innovations and more than half of them report process innovations. Results are robust across firm sizes, with greater GVC participation differentials for larger firms. In addition, the share of GVC-participating firms that fully foster the potential of the 4IR is 18.4%, as opposed to 11.3% otherwise. Participation in GVCs is also positively associated with the adoption of digital technologies across all survey questions. Chart 8 shows the average marginal effect of GVC participation on the adoption of digital technologies stemming from an ordered logit model controlling for sector and firm size. The effect is statistically significant at the 1% level for five out of the six questions (Table A2 in the Appendix presents the estimation results).

## 5. Vertical targeting

### 5.1 Greece's export performance

Greece entered the crisis era with a massive current account deficit. After the implementation of the structural adjustment programs, overall trade balance gradually improved, as a result of a stabilization of imports and an increase in exports (see Chart A1 in the Appendix). Exports of goods improved after 2016, to complement the services exports, mostly boosted by the sectors of travel and transportation. These two reached 85% of total service exports prior to the COVID-19 pandemic outbreak. Travel restrictions then also led to the collapse of services exports, and the current account deficit gradually widened. The fast recovery from the COVID-19 pandemic however was followed by a large boost to trade: excluding fuel products, exports of goods rose by 25% from 2019 to 2021.[19] On the other hand, imports of goods also increased substantially, and the overall trade deficit rose to over 10% of GDP in 2022, albeit to some extent due to the steep rise in energy prices. In 2023, current account deficit is expected to decrease substantially compared to 2022 due to falling global energy prices combined with increasing trends in Greek exports of goods and travel services as well as the NGEU funds.[20]

However, there is still a significant concern about the structure of Greece's external sector and, in particular, for the dependency on imported inputs prominently observed in the case of oil, and extending to the realm of tourism, where a substantial reliance on imported goods for accommodation and food is evident. A recent study highlighted that Greek hotels exhibit a remarkably high reliance on imported goods for their culinary offerings, exceeding 60% for 1-2 star establishments and

[19] Exports of refined oil products represent roughly a third of Greek goods exports. These can confuse the overall picture, both because they can be very volatile, but also because virtually all crude oil is imported, and so the overall impact of oil on trade is negative. As such, ELSTAT produces estimates of trade with and without oil. The estimates without oil are not deflated, and these deflators are not available, but price increases in 2021 were modest, and so this increase is not driven by price effects.

[20] https://www.bankofgreece.gr/Publications/NomPol20222023.pdf

approximately 35% for those rated over 3 stars (Skylakaki and Benos, 2023).

Although Greece showed some promising signs over the last three years, the above reflect the limited competitiveness of Greek products, and their inadequate differentiation and penetration into foreign markets. Chart 8 shows the extensive margin of trade for Greece, Portugal and Spain across time. The extensive margin is given by the number of distinct product-destination pairs a country exports.[21] Greece moved closely with both Portugal and Spain until the crisis hit, but then diverged sharply. While the other two continued growing their export variety basket, Greece remained stagnant for several years, and started an earnest growth only in 2016. This mirrors well the overall macroeconomic trajectory of Greece, suggesting the important role for overall investment, but also financial constraints (in particular, trade credit), and uncertainty. Another explanation is that the reform packages were excessively focused on labour market adjustment, and much less so on product markets or export-related areas (Petroulakis, 2017).[22] Yet, as seen from Chart 9, Greece's export base is lately slowly becoming more diversified.

There are many alternative approaches to measure export diversification. The Herfindahl-Hirschman Index (HHI) measures the degree to which a country's exports are dispersed across different products (or destinations). A value close to 1 implies a high degree of export concentration on a limited number of product categories (or a few trading partners). Chart 10 shows the trajectory of export concentration along with the number of exported products for Greece from 2005 to 2019. The sharp increase in export concentration after 2010 is underpinned by the elevated importance of oil and refined products. However, the HHI index remains above 0.1 until 2019, despite the rebound in the number of the exported products.[23]

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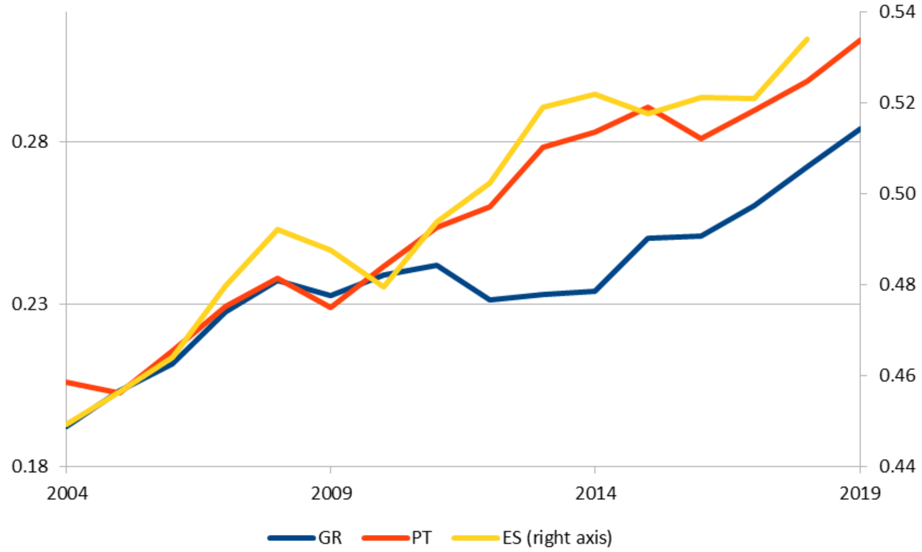
[21] We use the Hummels and Klenow (2005) extensive margin, defined in the appendix.

[22] The growing number of export markets tapped could partly also be attributed to the growing number of bilateral Free Trade Agreements (FTAs) and Economic Partnership Agreements signed by the EU. https://policy.trade.ec.europa.eu/eu-trade-relationships-country-and-region/negotiations-and-agreements_en

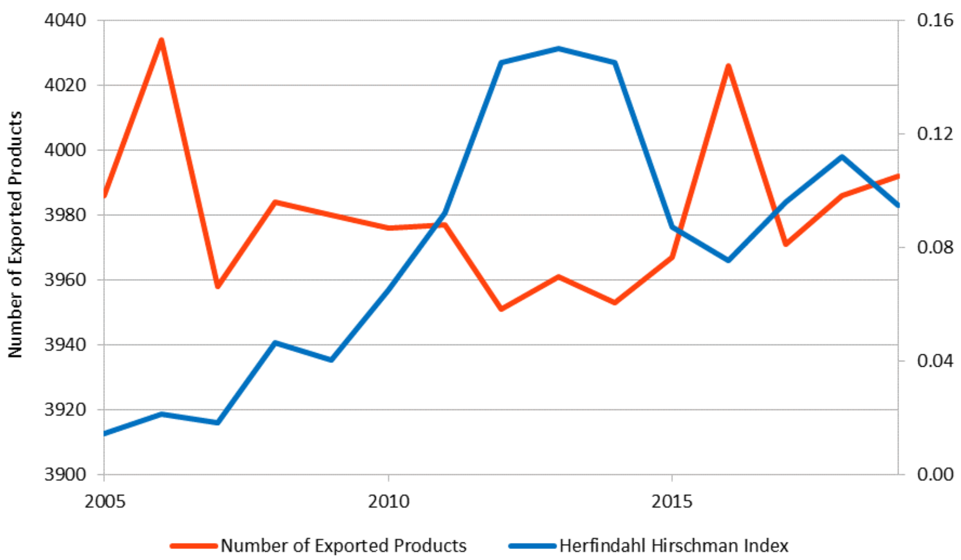
[23] Chart A2 in the Appendix shows the relatively high concentration of Greek exports within the OECD group.

**Chart 9 Extensive margin of trade**




Source: UN COMTRADE.
Notes: The chart show the extensive margin of trade measure of Hummels and Klenow (2005), for Greece, Spain, and Portugal. The scale is from 0 to 1.

**Chart 10 Export product concentration**




Source: UN COMTRADE

## 5.2 Greece's sectoral comparative advantage

To evaluate Greece's sectoral comparative advantage, we proceed in three stages. First, we estimate the revealed comparative advantage (RCA) to identify the product categories in which Greece enjoys competitive advantage. Then, we employ the PRODY and EXPY indices to study Greece's products' degree of sophistication and quality. Finally, we focus on the country-based Economic Complexity Index (ECI) and product-based Product Complexity Index (PCI), which were originally introduced in Hidalgo and Hausmann (2009) to infer the “complexity” (or technological sophistication) of countries’ production capabilities.

A country is said to have a RCA in a given product $i$ when the ratio of exports of this product to its total exports of all goods (products) exceeds the same ratio for the world as a whole (Balassa, 1965). RCA is therefore essentially a normalized export share:

$$RCA = \frac{x_i^r / \sum_{j=1}^{N} x_j^r}{x_i^W / \sum_{j=1}^{N} x_j^W} \qquad (3)$$

where $X$ are the exports of product $i$ from country *r*, the world is denoted with $W$, and $N$ is the set of all products ($j = 1, \dots, N$). A country has RCA for a given product if $RCA > 1$. With the 3-digit product classification, Greece has RCA for 69 out of 252 product categories.

More importantly, breaking down product groups by technological sophistication (Lall, 2000)[24] reveals that Greece exhibits RCA for only one out of 17 products in the high-tech manufacturing group[25] and for 14 out of 71 products in the medium-tech manufacturing group (see Chart A3). Most products with RCA greater than unity are in the resource-based manufactures group (24 products) followed by primary products (20); these two categories account for 64% of products with comparative advantage.

Hausmann et al. (2007) popularized the PRODY and EXPY indices as methods of calculating measures of export sophistication. These indices aim to identify products that have high sophistication levels and, therefore, according to the results of Hausmann et al. (2007), growth-enhancing effects. PRODY is given as follows:

$$\text{PRODY} = \frac{\Sigma\left(\frac{x_{ik}}{X_i}\right)}{\left(\frac{x_{wk}}{X_w}\right)} * y_i \qquad (4)$$

where $y_i$ is GPD per capita of country $i$, $X_i$ is total value of exports of country *i*, $w$

[24] Lall (2000) distinguishes between five categories: (i) primary products; (ii) resource-based manufactures; (iii) low-tech manufactures; (iv) medium-tech manufactures; and (v) high-tech manufactures.
[25] Product code 542: Medicaments (incl. veterinary).

denotes world, and $x_{ik}$ is country's $i$ exports of good $k$. PRODY is then high for goods that rich countries export in proportions higher than average, hence a higher PRODY indicates a more sophisticated product.

EXPY, in turn, is the weighted average of PRODY for each country, with the weights being the shares of each good in the country's export basket. A high EXPY value implies that the country's export basket is more sophisticated: if a country exports products typically exported by rich countries, it records higher values of EXPY. Rich countries typically have higher values of EXPY.

EXPY is thus the "expected" value of a country's GDP per capita, given its exports:

$$EXPY_i = \sum_k \left(\frac{x_{ik}}{X_i}\right) * PRODY_k \qquad (5)$$

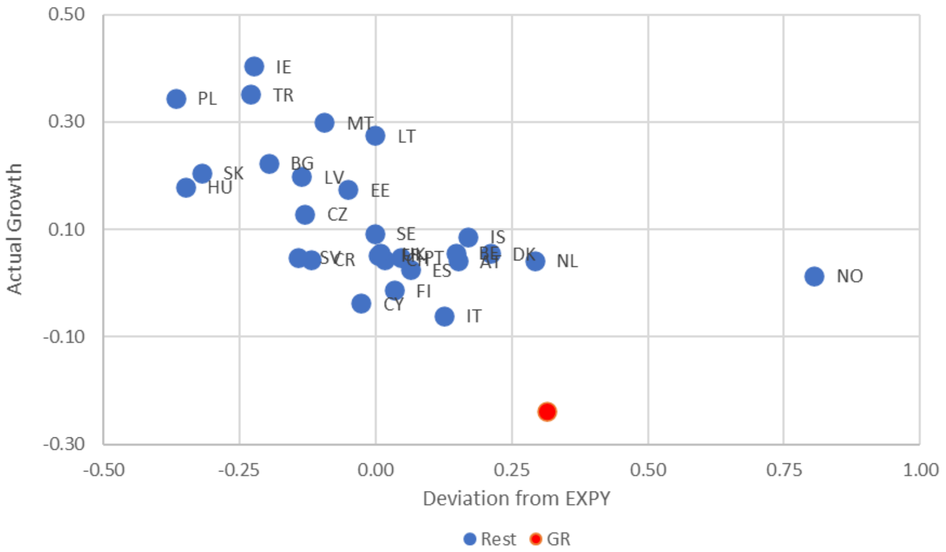
As EXPY is an indicator of "expected" GDP given the structure of exports, it can also provide a benchmark for assessing growth potential. Countries with high EXPY relative to current development levels may be expected to grow faster than countries with EXPY lower than suggested by their development levels. This is precisely what Chart 11 shows. The x-axis shows deviations from predicted values in simple regression of log GDP per capita levels versus log EXPY in 2008; higher values indicate GDP per capita being too high relative to EXPY. The y-axis shows actual log growth in GDP per capita from 2008 to 2018.

We see a tight relationship between actual growth and deviations from GDP per capita as predicted from EXPY in 2008.[26] This is exactly what Hausman et al. (2007) argued: the production of technologically sophisticated products in laggard countries exhibits a high degree of externality, as this success allows more firms to ascertain production is profitable, socialising success (while keeping failure private). The idea is then that some goods a country specialises in will yield higher subsequent growth than others, over and above fundamentals (physical and human capital, natural resources, institutions etc.). Cherif et al (2018) find that export sophistication is the only robust determinant of economic growth among commonly used predictors like human

[26] Note that this formulation implicitly controls for the expected convergence of poorer to richer countries; for instance, Poland is expected to grow faster than Denmark. Instead, this exercise examines whether Poland grew faster than Croatia, a country with similar GDP per capita in 2008, but substantially lower EXPY.

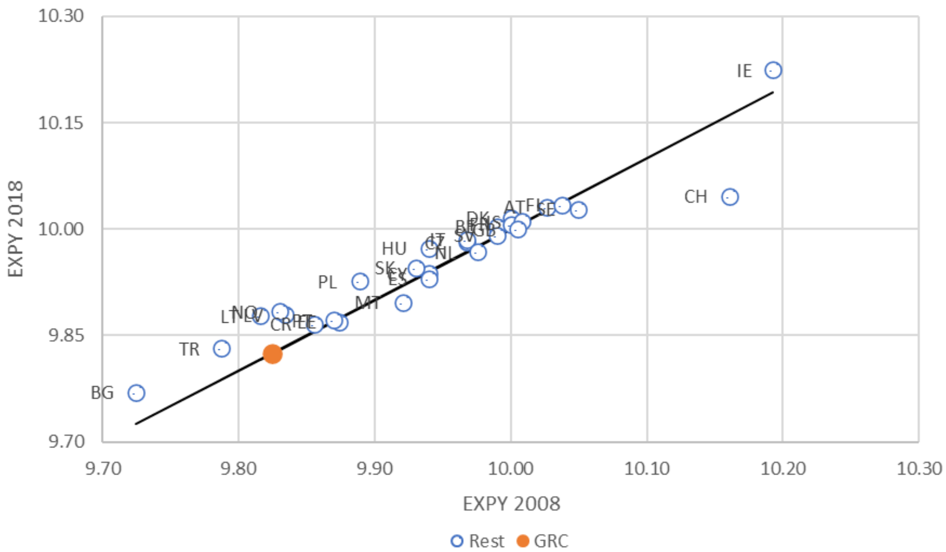
capital, trade openness, and institutional development.

**Chart 11 GDP growth and EXPY**




Source: UN COMTRADE

**Chart 12: EXPY analysis**




Source: OECD and UNCTAD (2018).

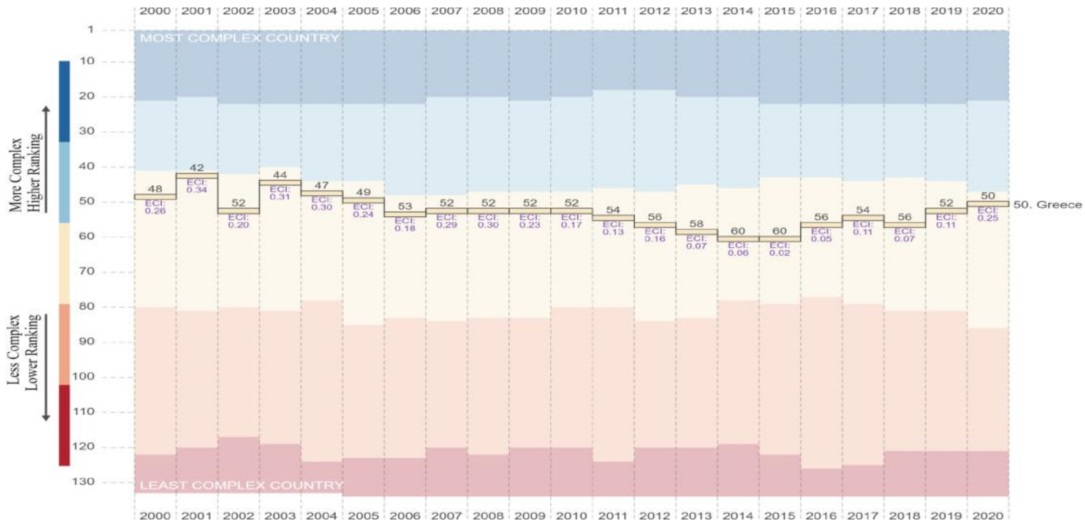
Among European Economic Area countries in 2008, Greece had an exceptionally high deviation of actual GDP per capita relative to what was predicted from its EXPY level. As such, even absent the crisis, this simple depiction shows that growth would still have been low.[27] The key takeaway from this exercise is Greece must increase the technological sophistication of its exports. However, as of 2018 (the last year of available data), EXPY was exactly at the level of 2008, at levels far below peer countries (Chart 12).

In their seminal paper, Hidalgo and Hausmann (2009) show that countries whose exports are more complex than expected for their income level grow faster. According to their analysis, two distinct processes can have substantial growth-enhancing effects (1) diversification, and (2) increasing knowhow (expertise and technological infrastructure) used in the production of the goods and services. A country's economic complexity mirrors the diversity and ubiquity of its products (see Appendix B for a formal definition). The Atlas of Economic Complexity, a data visualization tool constructed by Harvard's Growth Lab, shows that Greece ranked 50th out of 133 countries in the Economic Complexity Index (ECI ranking) in 2020 (Chart 13). Greece mainly exports goods characterized by low complexity, such as Agriculture and Minerals. Chemicals, Machinery and Electronics are amongst the most complex products that Greece exports (Chart A4).

The global financial crisis resulted in a substantial reduction in Greece's export complexity. Yet, from 2016 to 2020, the country saw an improvement of ten positions in the ECI ranking. Chart 14 shows export growth dynamics with respect to product complexity. Chemicals, especially Pharmaceuticas, display the largest export growth among highly complex products (25.19% annual export growth in the last five years), and account for roughly 30% of total highly complex exports. Other highly complex products with high export growth in the last five years are Electrical machinery and equipment in the Electronics sector (4.5%), and Industrial Machinery (4.5%) and Apparatuses (optical, medical, etc.) in the Machinery sector (9.1%). Finally, the Complexity Outlook Index (COI), a measure of how many complex products are near a country's current set of productive capabilities, ranks Greece 20th out of 133 countries, underscoring the potential for great improvement.

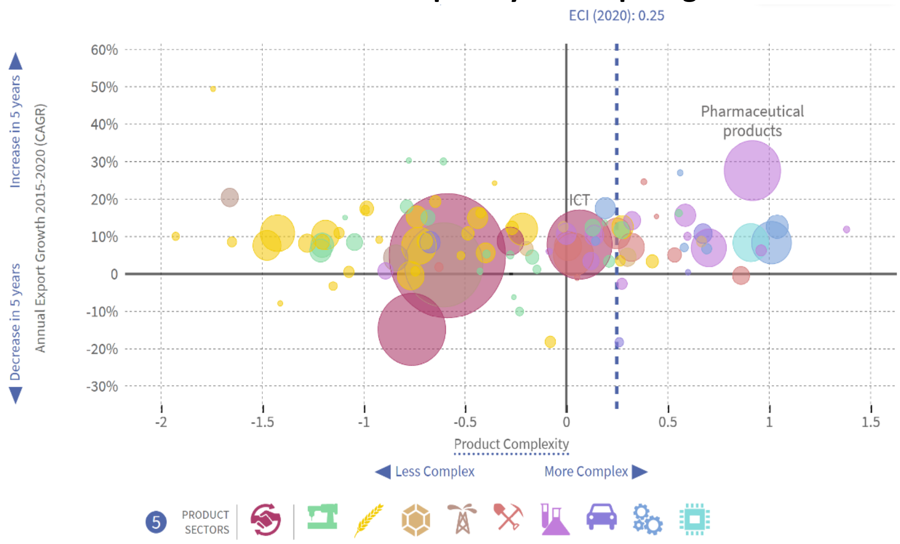
[27] Note that the only outlier is resource-rich Norway. High exports of natural resources both inflate GDP per capita and reduce EXPY, as natural resources tend to be exported by lower income countries in higher proportions than good exported by higher income countries.

**Chart 13: Economic Complexity Index ranking**




Source: Atlas of Economic Complexity *(see: [The Atlas of Economic Complexity](#))*

**Chart 14: Product complexity and export growth**




Source: Atlas of Economic Complexity *(see: [The Atlas of Economic Complexity](#))*

Overall, based on the above findings, the Atlas of Economic Complexity suggests that Greece has many opportunities to diversify its economy, and recommends doing so focusing on a Parsimonious Industrial Policy Approach, which requires addressing bottlenecks, to help jump short distances, into related products. Strategic new products should aim to balance: (1) distance to existing capabilities (the product can be easily manufactured with the existing knowhow); (2) complexity (more complex products imply higher wages); (3) opportunity gain for future diversification (allowing more linkages to other high-complexity products). Table A3 displays the top 50 new product opportunities identified for Greece following the Parsimonious Industrial Policy Approach with Balanced Portfolio.

For a parsimonious industrial policy to be successful, it should focus on improving the provision of public inputs to existing activities. The best sources of information for the identification and co-development of public inputs are existing firms as opposed to a strategic bets approach, where the key players may not yet exist. The first step is therefore the establishment of a public-private dialogue in order to identify sector-specific constraints. If such dialogue is to be effective, it needs to take place at a high level of disaggregation to ensure that each individual sector is heard (Hausmann, 2008). In this process, the public sector could face three problems: (1) an information problem, that would impede it to identify the public inputs needed to be provided; (2) an incentive problem, which even if the appropriate public inputs are known, could lead to inappropriate actions as the reward for increased productivity might be lower than rent provision; (3) a resource problem, due to the absence of a decentralized mechanism to mobilize resources. To overcome those problems and achieve a dialogue, Hausmann and Rodrik (2006) and Hausmann, Rodrik, and Sabel (2008) propose to (1) make the process transparent to limit rent-seeking; (2) allow the private sector to self-organize to identify common requirements; (3) focus on interventions that will increase a sector's productivity rather than profitability – which would simply imply redistribution; (4) establish *ex-ante* success criteria, for an early diagnosis of non-performers; (5) ensure accountability takes place, so that non-performers go as early as possible; (6) establish a sunset close to ensure financial commitments are not open-ended; (7) universalize a formal process which could be expanded or re-designed to benefit more sectors.

These guidelines together with the list of new products a country should aim to produce is a good starting point for policymakers to examine whether it is truly feasible to diversify into those products and identify any possible constraints that could hinder such an endeavour.

### 5.3 Determinants of export sophistication

In this section we attempt to gauge the impact of structural country attributes on the degree of export sophistication, measured by (log) EXPY, using a panel of 99 advanced and developing economies over the 2008-2019 period. Although there is no theoretical consensus on the determinants of export sophistication, we rely on a parsimonious set of control variables, following the relevant empirical literature.

In all regressions, we account for: (i) inward FDI stock (% of GDP), since ownership advantages of Multinational Corporations are associated with technology transfer and productivity spillovers (Harding and Javorcik, 2012; Javorcik et al., 2018); (ii) financial development (domestic credit to the private sector as a share of GDP), since efficient capital allocation promotes productivity growth and technological upgrading (Atasoy, 2021; Nguyen et al., 2020); (iii) research and development (R&D) expenditure (% of GDP), which contributes to innovation capacity and productivity enhancement (Spatafora et al., 2012; Xu and Lu, 2009).; (iv) human capital accumulation (proxied by secondary education enrolment[28]), since an educated workforce is expected to catalyze sophisticated exports of goods and services (Atasoy, 2020; Spatafora et al., 2012; Wang and Wei, 2008); (v) trade openness (% of exports and imports in GDP), to capture productivity spillovers associated with increased participation in global trade (Spatafora et al., 2012; Nguyen et al., 2020); and (vi) population, to capture market size effect (Hausman et al., 2007; Weldemicael, 2012).

We control for GDP per capita, as our main research question is what drives export sophistication beyond fundamentals (i.e., the level of development (Rodrik, 2006)). To assess the relevance of industrial policy for export specialization, we also include the share of manufacturing value added over GDP. Manufacturing sectors are associated with higher levels of productivity and sophistication, are more likely to develop linkages within and across sectors, whereas shifting production towards manufacturing activities also implies a deviation from comparative advantage towards more sophisticated activities for many developing economies (Gala et al., 2018; Pisano and Shih, 2009). A positive and significant coefficient of this variable would imply that

[28] The indicator is chosen as it is widely available for the countries in our sample, which is not the case for other indicators. Results remain unchanged when restricting the sample to OECD economies and selected emerging markets and using, instead, tertiary enrolment.

a shift towards manufacturing activities promotes export sophistication, conditional on the structural characteristics described above.

In further regressions we also include some institutional variables as controls; the Frontier Technology Readiness Index (TRI) sub-indicators related to ICT, Skills and Industry activity; broadband subscriptions per 100 people; the Global Competitiveness Index variables capturing state of cluster development and research institutions prominence. Sophisticated exports associated with more complex products and aiming at penetrating advanced markets can be associated with advancements in technological capacity and up-skilling in the domestic economy.[29]

We estimate regressions of the following form:

$$EXPY_{it} = a_0 + a_1 GDP_{it} + +a_2 FDI_{it} + a_3 Financial\ Development_{it} + a_4 R\&D_{it} + a_5 Human\ Capital_{it} + a_6 Trade_{it} + a_7 Population_{it} + a_8 Manufacturing\ VA_{it} + \beta_1 Institution_{it-1} + Region_i + \gamma_t + \varepsilon_{it} \quad (6)$$

where $i$ represents the country and $t$ the time dimension. We include all institutional indicators with a one-period lag considering the long-run effect of structural attributes and as a first attempt to tackle potential endogeneity.[30] We also include year and region dummies.

Table 3 presents the results from OLS regressions. There is a strong, sizable association of EXPY with economic development, robust across all specifications. In addition, there is a strong effect for R&D expenses, indicating that inputs to the innovation process matter for export specification. A large internal market and a growing participation in global trade also appear to contribute to increasing export sophistication, as is the case for domestic financial development. The results also underline that a shift in the composition of economic activity towards manufacturing significantly contributes to export sophistication, controlling for GDP per capita and structural characteristics, in line with the findings of Gala et al. (2018). Increasing the share of manufacturing value added by one percentage point is associated with a 0.5% increase in the EXPY index. The latter implies an increase in EXPY of approximately 3.5% for Greece if the country moves from its share of 7.5% to the OECD average of

[29] Tables A4 and A5 list the variables included in the empirical analysis and present summary statistics.
[30] Results with two-period lags are very similar.

14.4% (2019 data). This provides preliminary evidence on the conducive role of industrial policy towards the sophistication of exported products and thus future economic growth.

Moreover, all indicators associated with technological capacity, digitalization and digital skills significantly increase EXPY. A one standard deviation (SD) increase in the TRI Skills increases EXPY by 2.3%. A similar effect is noted for the TRI ICT, an important finding, as Greece scores lags behind the OECD in the TRI ICT sub-indicator (Chart A5). This effect underlines the potent role of structural transformations that enhance digital transformation. Moreover, using data for 2017 (latest available) we find that if Greece reaches OECD average in clusters development, EXPY will increase about 3%. This underscores the material role of enhanced synergies across sectors. Greece is among the laggards in cluster development globally and clearly in last place in the OECD group (Chart A6).[31]

Overall, our results confirm the evidence on the conducive effect of institutional and structural characteristics for export sophistication, on top of economic fundamentals, and mainly GDP per capita (Hausman et al., 2007; Weldemicael, 2012; Lapatinas, 2019).

[31] In a second set of regressions, we include one period lagged value of EXPY to address the high persistence of the export sophistication variable and construct a dynamic panel, using the System GMM method. The results in Table A6 corroborate the main findings, in terms of significance and magnitude of the effects of manufacturing and structural indicators controlling for the potential endogeneity of institutional variables and accounting for persistence in EXPY levels within countries.

## Table 3: Regression analysis of export sophistication

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| GDP | 0.151*** | 0.132*** | 0.130*** | 0.119*** | 0.129*** | 0.120*** | 0.124*** |
| | (0.013) | (0.015) | (0.016) | (0.013) | (0.014) | (0.016) | (0.015) |
| FDI | 0.004*** | 0.003* | 0.003* | -0.002 | 0.001 | 0.003 | 0.003* |
| | (0.001) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) |
| Financial Development | 0.015*** | 0.022*** | 0.025*** | 0.021*** | 0.022*** | 0.027*** | 0.025*** |
| | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) |
| R&D | 0.048*** | 0.051*** | 0.052*** | 0.029*** | 0.042*** | 0.057*** | 0.041*** |
| | (0.005) | (0.005) | (0.005) | (0.006) | (0.005) | (0.006) | (0.007) |
| Human Capital | -0.016 | 0.015 | -0.018 | -0.003 | -0.013 | 0.046 | 0.008 |
| | (0.029) | (0.030) | (0.031) | (0.027) | (0.028) | (0.031) | (0.033) |
| Trade | 0.081*** | 0.085*** | 0.090*** | 0.047*** | 0.086*** | 0.093*** | 0.089*** |
| | (0.009) | (0.011) | (0.011) | (0.011) | (0.011) | (0.012) | (0.012) |
| Population | 0.013*** | 0.015*** | 0.017*** | 0.001 | 0.013*** | 0.010** | 0.010*** |
| | (0.003) | (0.003) | (0.004) | (0.003) | (0.004) | (0.004) | (0.004) |
| Manuf/ing VA | 0.005*** | 0.005*** | 0.005*** | 0.002*** | 0.005*** | 0.005*** | 0.006*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| TRI ICT | | 0.088** | | | | | |
| | | (0.036) | | | | | |
| TRI Skills | | | 0.122** | | | | |
| | | | (0.052) | | | | |
| TRI Industry | | | | 0.453*** | | | |
| | | | | (0.040) | | | |
| Broadband | | | | | 0.003*** | | |
| | | | | | (0.001) | | |
| Clusters | | | | | | 0.021** | |
| | | | | | | (0.008) | |
| Research | | | | | | | 0.037*** |
| | | | | | | | (0.008) |
| Constant | 7.885*** | 7.957*** | 7.941*** | 8.206*** | 8.063*** | 8.077*** | 8.008*** |
| | (0.150) | (0.143) | (0.138) | (0.135) | (0.148) | (0.167) | (0.160) |
| Observations | 711 | 630 | 630 | 630 | 645 | 585 | 585 |
| R-squared | 0.789 | 0.790 | 0.789 | 0.832 | 0.775 | 0.770 | 0.775 |
| Region FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

Source: Authors' calculations based on data from COMTRADE, World Bank, World Economic Forum and UNCTAD.
Notes: The dependent variable for all models is the logarithmic of EXPY. The estimation method is OLS with year and region fixed effects. The sample period is 2009-2019 for columns (1)-(5) and 2009-2017 for columns (6)-(7). The lower part of the table also reports the number of observations and the R-squared. Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1**.**

## 6. Conclusions

The focus of the first part of this paper revolves around skills and management practices, together with an extensive analysis of innovation activities and technological readiness among Greek firms. We prioritize these areas due to their significance for growth and the urgent need for improvement. The empirical findings provide ample fodder for concrete policy proposals in these areas with the aim to increase productivity in Greek manufacturing.

First, education, skills and labour market policies should ensure that workers are equipped with the right skills and that businesses can flexibly deploy workers to meet changing labour market needs. The implementation of these policies will help ensure that technology adoption has a positive impact on both productivity and workers. Persistent skills gaps and mismatches come at economic and social costs, while skills constraints can negatively affect labour productivity and hamper the ability to innovate and adopt technological advances. Second, Greece's low performance in innovation and knowledge diffusion points to an urgent need for a long-term national strategy, aimed at enhancing innovation, knowledge and technological capabilities, resting on the triplet of innovation and R&D, fostering of skills, and knowledge-intensive entrepreneurship. Innovation is a catalyst for long-term growth and therefore countries require a long-term national strategy involving the implementation of an effective innovation system, which promotes interaction among stakeholders and networking between knowledge creators and those willing to promote and commercialise research results and technical ideas.

At the same time, shaping concrete policy recommendation warrants understanding the determinants of export sophistication and distinguishing between structural determinants, comparative advantage predicted by standard trade theory and concrete policy initiatives at the horizontal and vertical level. For this reason, the second part of the paper focuses on export performance and export sophistication. Export sophistication varies significantly across economies, even within income groups. Hausman et al. (2007) postulate that "what you export matters" and that shifting the composition of exports towards more sophisticated products and services is a robust determinant of subsequent economic growth. Divergent trajectories in export sophistication can arise from market fundamentals mirrored in indicators such as GDP per capita and economic growth, trade patterns especially evident in high technology imported inputs for domestic manufacturing and coordinated efforts to steer export composition towards goods and services of a higher sophistication level. Using a panel of advanced and emerging economies, we find that shifting production towards manufacturing, investing in skills and technology upgrading, and promoting digitalization and clusters of knowledge enhance export sophistication at the country level. It is the latter effect that highlights the role and impact of industrial policy in export upgrading and, hence, economic growth.

The original proposition of industrial policy in Hausmann et al. (2008) recognized that identifying all the various market failures and distortions inhibiting growth is a daunting task; instead, they propose that the state, instead of trying to put in place specific micro-fixes, like Pigovian taxes, provides missing inputs and helps solve coordination problems in the private sector that prevent markets from developing. This can allow improved performance on existing activities and increase the likelihood that opportunities in nearby activities will be exploited. We showed that Greece is ripe for such an approach, because it sorely needs an improvement in inputs, its export sophistication is markedly lower than its peers, all the while a large number of complex products are near its current product space.

But while this approach may be useful for developing countries, we caution that it should only be selectively applied to a country in a low upper income position like Greece, which needs a balanced portfolio of complex products to advance towards the frontier. In particular, given the high concentration of low-productivity exports and the influence these sectors have, misapplied parsimony may risk further focus on sectors like tourism, transportation, and the primary sector. On the other hand, excessive parsimony, even for complex products, may imply overt specialization in few industries, which can reduce resilience to sectoral shocks, preclude deeper integration in global value chains, and engender Dutch disease-type of problems. As such, parsimony can be useful in the short- to medium-run, by introducing higher complexity in the most feasible fashion, and taking into account the limited home market size. However, it must be carefully applied, otherwise it risks precluding growth in areas further away from current activities, which may potentially be achievable in the long-run, especially given the opportunities afforded by Greece's presence in the largest trading block in the world.

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## Appendix A: Additional results

### Table A1 Management score and productivity

| | Overall management (1) | Lean operations (2) | Monitoring (3) | Target-setting (4) | People management (5) |
|---|---|---|---|---|---|
| Management score | 0.247*** | 0.163*** | 0.159*** | 0.193*** | 0.104 |
| | (0.072) | (0.057) | (0.052) | (0.053) | (0.076) |
| Multinational Ownership | 0.233** | 0.253*** | 0.264*** | 0.253*** | 0.302*** |
| | (0.091) | (0.095) | (0.092) | (0.087) | (0.095) |
| Age 10-19 years | 0.557*** | 0.559*** | 0.691*** | 0.519*** | 0.551*** |
| | (0.159) | (0.160) | (0.147) | (0.161) | (0.165) |
| Age 20+ years | 0.901*** | 0.862*** | 1.013*** | 0.864*** | 0.880*** |
| | (0.095) | (0.098) | (0.087) | (0.098) | (0.105) |
| 10-49 employees | -1.273* | -1.102 | -1.237 | -1.305* | -1.182 |
| | (0.716) | (0.693) | (0.758) | (0.770) | (0.764) |
| 50-249 employees | -1.152 | -1.045 | -1.111 | -1.182 | -1.061 |
| | (0.700) | (0.672) | (0.741) | (0.754) | (0.747) |
| 250 + employees | -1.136 | -0.996 | -1.090 | -1.141 | -1.002 |
| | (0.704) | (0.676) | (0.745) | (0.760) | (0.752) |
| Constant | 11.949*** | 12.040*** | 11.990*** | 12.181*** | 12.259*** |
| | (0.730) | (0.705) | (0.762) | (0.758) | (0.777) |
| Observations | 277 | 276 | 277 | 277 | 277 |
| R-squared | 0.416 | 0.415 | 0.410 | 0.415 | 0.394 |
| Sector FE | Yes | Yes | Yes | Yes | Yes |
| Robust SE | Yes | Yes | Yes | Yes | Yes |

Source: World Management Survey (WMS) and ORBIS.
Notes: The dependent variable for all models is labour productivity defined as the natural logarithm of operating revenue divided by the number of employees. Overall management score (including all questions) and sub-indices of the questions covering each of the portions of the questionnaire (lean operations, monitoring, target-setting and people management). A full set of questions can be found on www.worldmanagementsurvey.com. The estimation method is OLS with industry fixed effects. The lower part of the table also reports the number of observations and the adjusted R-squared. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

**Table A2 Family ownership, GVC participation and adoption of digital technologies for Greek manufacturing firms**

| | Big Data | New Generation networks | E-commerce | Advanced software | 3D printing | Advanced communications |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Family ownership | -0.56*** | -0.52*** | -0.46*** | -0.08 | -0.44** | -0.37*** |
| | (0.133) | (0.126) | (0.134) | (0.122) | (0.179) | (0.124) |
| GVC participation | 0.68*** | 0.60*** | 0.46** | 0.59*** | 0.75*** | 0.39** |
| | (0.182) | (0.174) | (0.183) | (0.174) | (0.236) | (0.174) |
| Collaboration for innovation | 0.61*** | 0.75*** | 0.67*** | 0.53*** | -0.21 | 0.52*** |
| | (0.141) | (0.135) | (0.142) | (0.135) | (0.202) | (0.134) |
| 11-49 employees | 0.13 | 0.28* | 0.15 | 0.57*** | 0.24 | 0.24 |
| | (0.167) | (0.158) | (0.167) | (0.162) | (0.236) | (0.158) |
| 50-249 employees | 0.65*** | 0.66*** | 0.43* | 1.01*** | 0.22 | 0.81*** |
| | (0.237) | (0.224) | (0.237) | (0.222) | (0.330) | (0.225) |
| >100 employees | 0.67*** | 0.70*** | 0.46* | 1.25*** | 0.44 | 0.83*** |
| | (0.245) | (0.240) | (0.254) | (0.239) | (0.344) | (0.235) |
| Observations | 872 | 890 | 885 | 893 | 887 | 890 |
| Industry FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Pseudo R sq | 0.0361 | 0.0360 | 0.0274 | 0.0318 | 0.0150 | 0.0229 |

Source: LIEE/NTUA.

Notes: The table reports the average marginal effect results (from ordinal logit regressions), whereby the dependent variable denotes agreement with five statements taking a score from 1 (indicating that the respondent is not using the specific technology at all) to 5 (indicating that the respondent is using the specific technology to a great extent). A constant term is included in the regressions. The lower part of the table also reports that number of observations and the pseudo R-squared. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

**Table A3 New product opportunities**

| Product | Sector | Global size | Global growth (5 years) |
|---|---|---|---|
| Machine tools for molding and forging metals (8462) | Machinery | $7.99B | ↓14.1% |
| Dish washing machines (8422) | Machinery | $30.7B | ↑18.6% |
| Furnace burners (8416) | Machinery | $2.42B | ↓0.5% |
| Parts of motor vehicles (8708) | Vehicles | $327B | ↓3.6% |
| Equipment for temperature change of materials (8419) | Machinery | $38.9B | ↑8.6% |
| Other parts for machines and appliances (9033) | Machinery | $2.85B | ↑2.2% |
| Tractors (8701) | Vehicles | $44.4B | ↓12.3% |
| Industrial furnaces (8417) | Machinery | $4.06B | ↓15.3% |
| Electric signal and traffic controls (8530) | Electronics | $2.38B | ↓11.1% |
| Vulcanized rubber plates (4008) | Chemicals | $3.84B | ↑3.6% |
| Other agricultural machinery (8436) | Machinery | $7.07B | ↑11.8% |
| Railway track fixtures (8608) | Vehicles | $0.81B | ↓16.4% |
| Vulcanized rubber tubes (4009) | Chemicals | $8.94B | ↑0.5% |
| Cars (8703) | Vehicles | $618B | ↓3.8% |
| Parts for use with electric generators (8503) | Electronics | $16.9B | ↑8.9% |
| Multiple-walled insulating glass (7008) | Stone | $1.90B | ↑20.3% |
| Parts for electrical apparatus (8538) | Electronics | $31.1B | ↑1.1% |
| Padlocks and locks (8301) | Metals | $11.8B | ↓2.4% |
| Pharmaceutical goods (3006) | Chemicals | $13.8B | ↑13% |
| Safety glass (7007) | Stone | $9.85B | ↑5.3% |
| Other articles of iron or steel (7326) | Metals | $46.2B | ↑10.2% |
| Pigments, nonaqueous (3212) | Chemicals | $1.95B | ↓2.3% |
| Other firearms (9303) | Machinery | $1.27B | ↑11.3% |
| Other articles of vulcanized rubber (4016) | Chemicals | $24.4B | ↑5.7% |
| Machinery for soil preparation or cultivation (8432) | Machinery | $8.01B | ↑26.7% |
| Harvesting or agricultural machinery (8433) | Machinery | $20.2B | ↑18.2% |
| Other articles of aluminum (7616) | Metals | $15.7B | ↑5.5% |
| Parts for use with hoists and excavation machinery (8431) | Machinery | $47.5B | ↓8.2% |
| Radiators for central heating of iron or steel (7322) | Metals | $3.27B | ↑6.3% |
| Wire etc. used for welding (8311) | Metals | $2.65B | ↓8.3% |
| Trailers and semi-trailers (8716) | Vehicles | $23.6B | ↑4.7% |
| Aluminum containers, >300 liters (7611) | Metals | $0.23B | ↑25.8% |
| Central heating boilers (8403) | Machinery | $6.74B | ↑9.8% |
| Munitions of war (9306) | Machinery | $6.02B | ↓23% |
| Baths, sinks etc. (3922) | Chemicals | $4.31B | ↑29.3% |
| Felt (5602) | Textile | $1.10B | ↓4.8% |
| Articles of cement, of concrete or of artificial stone (6810) | Stone | $10.0B | ↑28.8% |
| Refrigerators, freezers (8418) | Machinery | $46.1B | ↑16.5% |
| Glass fibers (7019) | Stone | $11.2B | ↑3.2% |
| New pneumatic tires of rubber (4011) | Chemicals | $67.6B | ↓2.9% |
| Electrical ignition equipment (8511) | Electronics | $16.8B | ↓3.8% |
| Other furniture and parts (9403) | Textiles | $88.4B | ↑13.2% |
| Machinery for the industrial preparation of food or drink (8438) | Machinery | $12.5B | ↑4.2% |
| Other cast articles of iron or steel (7325) | Metals | $5.94B | ↓6.3% |
| Other uncoated paper and paperboard (4805) | Agriculture | $13.4B | ↑24.7% |
| Polishes and creams (3405) | Chemicals | $2.39B | ↑18.4% |
| Other inorganic acids (2811) | Chemicals | $4.69B | ↑15% |
| Other bars and rods of other alloy steel (7228) | Metals | $9.92B | ↓49.3% |
| Finishing agents (3809) | Chemicals | $4.26B | ↑6.1% |
| Sheet piling of iron or steel (7301) | Metals | $1.73B | ↓7.5% |

Source: Atlas of Economic Complexity. *(see: The Atlas of Economic Complexity)*

## Table A4: Variable definitions and source

| Variable | Description | Source |
|---|---|---|
| EXPY | EXPY index in logarithmic form | COMTRADE |
| GDP | GDP per capita (PPP) in logarithmic form | World Bank – World Development Indicators |
| Population | Total population in logarithmic form | -"- |
| Human capital | Gross secondary enrolment, % of population | -"- |
| FDI | Inward FDI stock, % of GDP | -"- |
| R&D | Research and Development expenditures % of GDP | -"- |
| Financial development | Domestic credit to the private sector, % of GDP | -"- |
| Trade | Trade openness: Imports + Exports, % of GDP | -"- |
| Manufacturing VA | Manufacturing Value Added, % of GDP | -"- |
| TRI ICT | Frontier technological readiness index – ICT. Index to assess the level of ICT infrastructure for using, adopting and adapting frontier technologies. | UNCTAD - Frontier technological readiness index |
| TRI Skills | Frontier technological readiness index – Skills. Index to assess the level of relevant skills for using, adopting and adapting frontier technologies. | -"- |
| TRI Industry | Frontier technological readiness index - Industry activity. Index to assess the level of relevant industrial capacity for using, adopting and adapting frontier technologies. | -"- |
| Broadband | Fixed broadband connections per 100 people | World Bank - World Development Indicators |
| Clusters | State of cluster development. Sub-pillar of the pillar 12 Innovation capability of Global Competitiveness Index. Response to the survey question "In your country, how widespread are well-developed and deep clusters (geographic concentrations of firms, suppliers, producers of related products and services, and specialized institutions in a particular field)?" [1 = non-existent; 7 = widespread in many fields]. | World Economic Forum - Global Competitiveness Index |
| Research | Research institutions prominence. Sub-pillar of the pillar 12 Innovation capability of Global Competitiveness Index. Measures the prominence and standing of private and public research institutions. | -"- |

## Table A5 Summary statistics

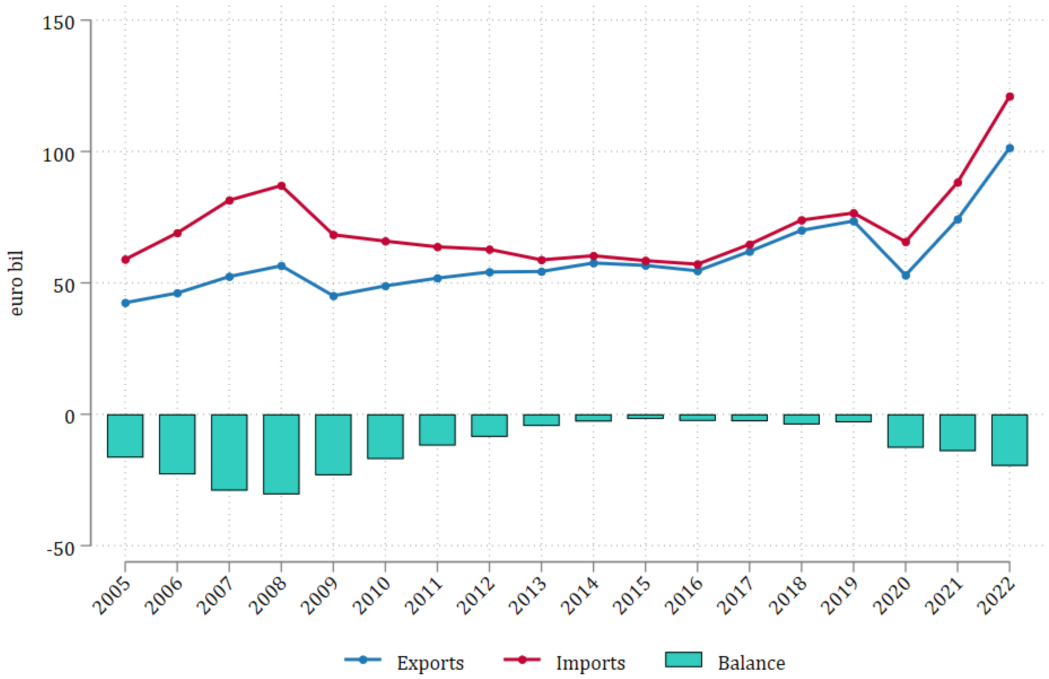
| | Mean | Median | Min | Max | SD |
|---|---|---|---|---|---|
| EXPY | 9.614 | 9.660 | 7.387 | 10.414 | 0.366 |
| GDP | 9.421 | 9.519 | 6.574 | 11.961 | 1.173 |
| FDI | 74.601 | 37.643 | 0.000 | 1986.488 | 191.854 |
| Financial Development | 62.568 | 48.323 | 0.005 | 525.704 | 57.790 |
| R&D | 1.070 | 0.706 | 0.011 | 5.140 | 1.028 |
| Human Capital | 86.990 | 95.055 | 10.914 | 163.935 | 27.921 |
| Trade | 92.226 | 80.23 | 11.855 | 442.620 | 57.821 |
| Population | 43.223 | 8.643 | 0.018 | 1402.760 | 153.715 |
| Manufacturing, value added (%) | 12.153 | 11.461 | 0.363 | 48.955 | 6.281 |
| TRI - ICT | 0.421 | 0.395 | 0.000 | 1.000 | 0.267 |
| TRI - Skills | 0.509 | 0.497 | 0.000 | 1.000 | 0.237 |
| TRI - Industry | 0.518 | 0.503 | 0.000 | 1.000 | 0.211 |
| Broadband | 12.546 | 7.668 | 0.002 | 61.256 | 12.912 |
| Clusters | 3.782 | 3.720 | 1.858 | 5.702 | 0.769 |
| Research | 3.945 | 3.753 | 1.459 | 6.550 | 1.040 |

## Table A6: System-GMM estimations

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| EXPYt-1 | 0.779*** | 0.782*** | 0.799*** | 0.000 | 0.550*** | 0.741*** | 0.709*** |
| | (0.019) | (0.034) | (0.017) | (0.000) | (0.025) | (0.022) | (0.018) |
| GDP | -0.020** | -0.041*** | -0.009 | 0.397*** | 0.035*** | 0.014 | -0.012* |
| | (0.009) | (0.010) | (0.007) | (0.003) | (0.009) | (0.016) | (0.006) |
| FDI | -0.003* | -0.003** | 0.003*** | 0.085*** | -0.002 | 0.005*** | -0.004*** |
| | (0.002) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.002) |
| Financial | 0.026*** | 0.020*** | -0.017*** | -0.251*** | -0.013 | -0.013*** | 0.015** |
| Development | (0.005) | (0.005) | (0.004) | (0.003) | (0.012) | (0.005) | (0.007) |
| R&D | 0.018*** | 0.025*** | 0.006* | 0.053*** | -0.007 | 0.005 | 0.050*** |
| | (0.003) | (0.005) | (0.003) | (0.001) | (0.004) | (0.005) | (0.003) |
| Human Capital | 0.024*** | 0.002 | 0.075*** | 0.037*** | 0.027** | 0.016 | 0.036*** |
| | (0.007) | (0.008) | (0.006) | (0.006) | (0.011) | (0.014) | (0.005) |
| Trade | 0.027*** | 0.043*** | 0.016*** | 0.142*** | 0.076*** | 0.039*** | 0.050*** |
| | (0.005) | (0.005) | (0.003) | (0.003) | (0.005) | (0.010) | (0.004) |
| Population | -0.008** | -0.007 | 0.001 | 0.327*** | 0.005 | 0.014*** | -0.009** |
| | (0.004) | (0.006) | (0.003) | (0.001) | (0.004) | (0.003) | (0.004) |
| Manufacturing VA | 0.003*** | 0.003*** | 0.001*** | -0.002*** | 0.001*** | 0.003*** | 0.003*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.001) | (0.000) |
| TRI ICT | 0.034*** | | | | | | |
| | (0.006) | | | | | | |
| TRI Skills | | 0.110*** | | | | | |
| | | (0.030) | | | | | |
| TRI Industry | | | 0.100*** | | | | |
| | | | (0.013) | | | | |
| Broadband | | | | -0.001*** | | | |
| | | | | (0.000) | | | |
| Clusters | | | | | 0.037*** | | |
| | | | | | (0.004) | | |
| Research | | | | | | 0.039*** | |
| | | | | | | (0.003) | |
| Constant | 2.372*** | 2.476*** | 1.890*** | 0.000 | 3.688*** | 1.882*** | 2.983*** |
| | (0.149) | (0.249) | (0.124) | (0.000) | (0.247) | (0.157) | (0.192) |
| Observations | 630 | 630 | 630 | 645 | 525 | 525 | 646 |
| Number of cnt | 90 | 90 | 90 | 98 | 88 | 88 | 98 |
| Region FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Sargan-Hansen Stat | 649.7 | 649.7 | 649.7 | 649.7 | 649.7 | 649.7 | 649.7 |
| AR(1) Test p-value | 0.0006 | 0.0006 | 0.0006 | 0.0006 | 0.0006 | 0.0006 | 0.0006 |
| AR(2) Test p-value | 0.353 | 0.353 | 0.353 | 0.353 | 0.353 | 0.353 | 0.353 |

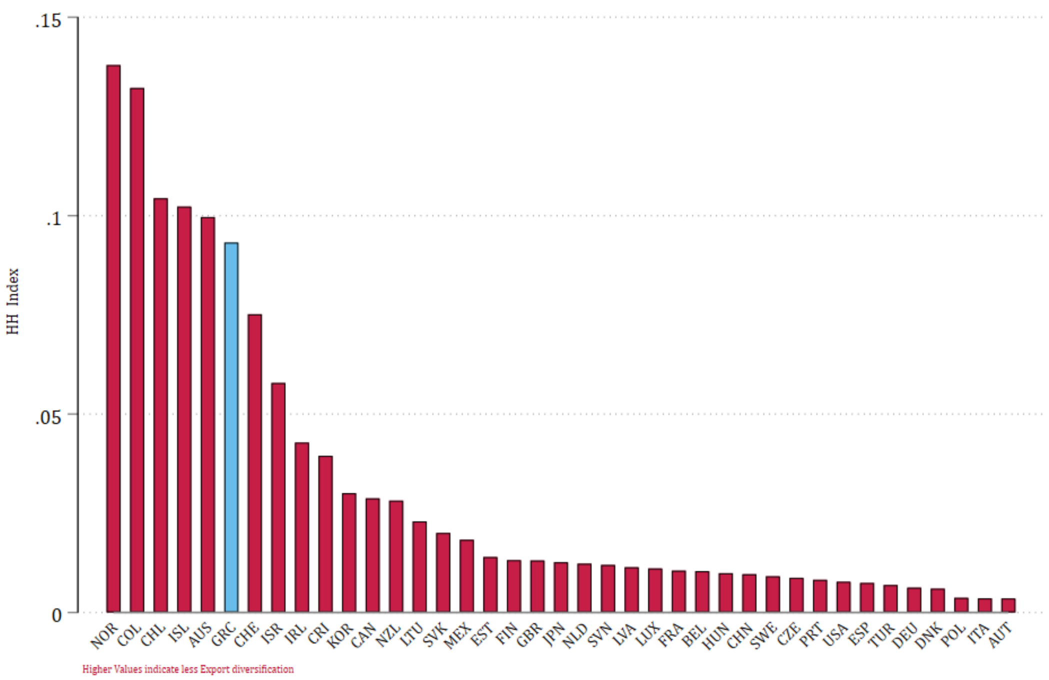
Source: Authors' calculations based on data from COMTRADE, World Bank, World Economic Forum and UNCTAD.
Notes: The dependent variable for all models is the logarithmic of EXPY. The estimation method is two-step system GMM. The sample period is 2009-2019 for columns (1)-(5) and 2009-2017 for columns (6)-(7). The lower part of the table also reports the number of observations and the R-squared. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

## Chart A1 Trade balance



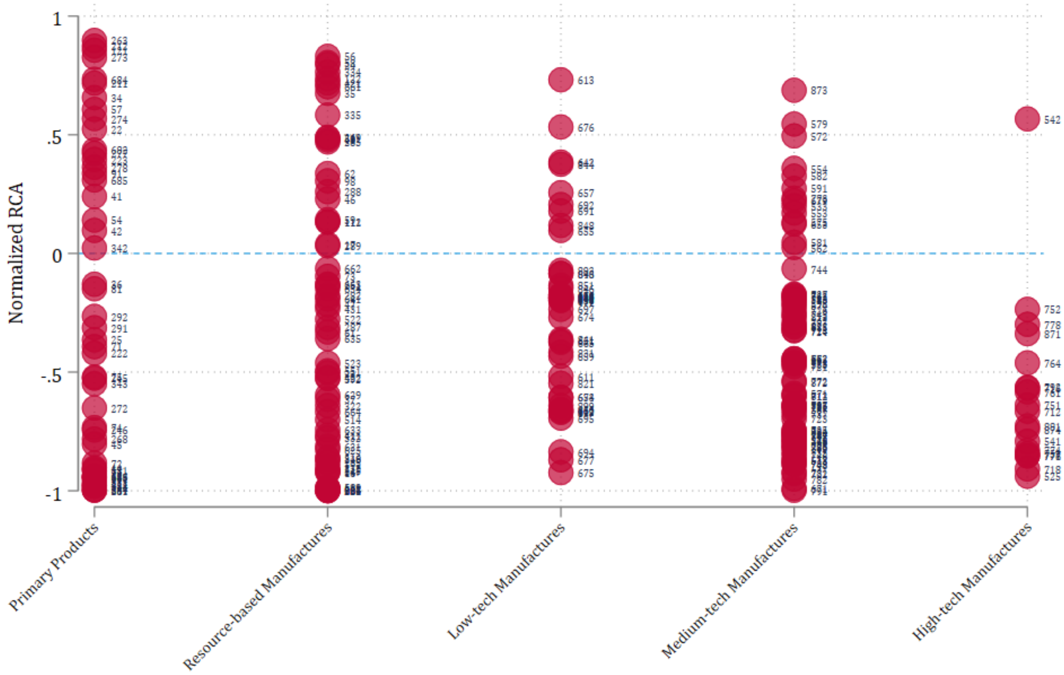

Source: Eurostat.

## Chart A2: Export Concentration HH Index – OECD Economies 2015-19



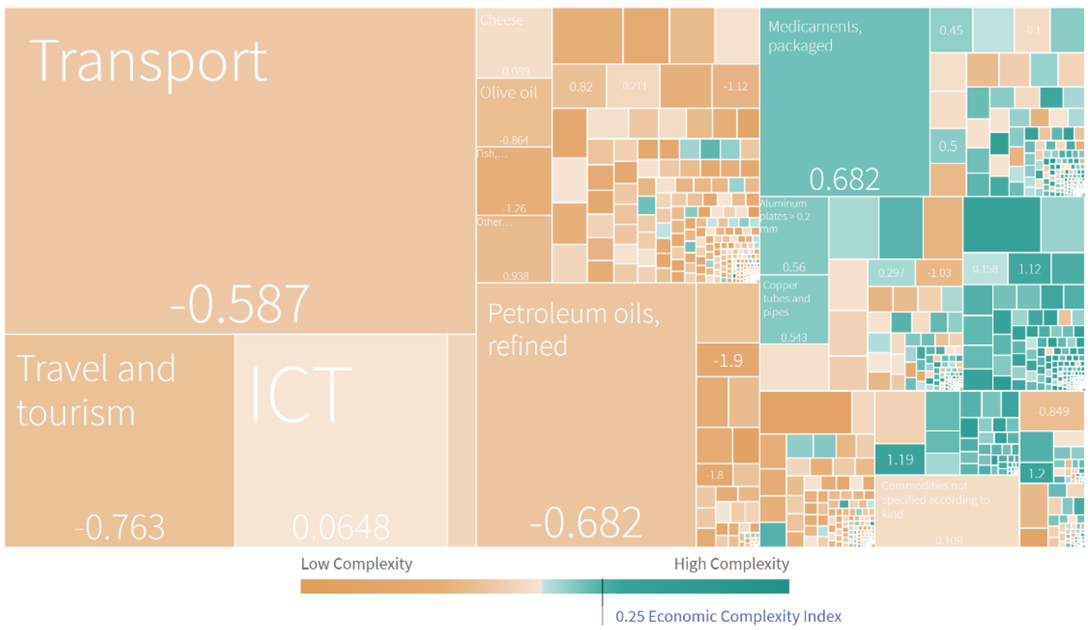

Source: UN COMRTADE.

**Chart A3: Revealed comparative classification and technology classification**



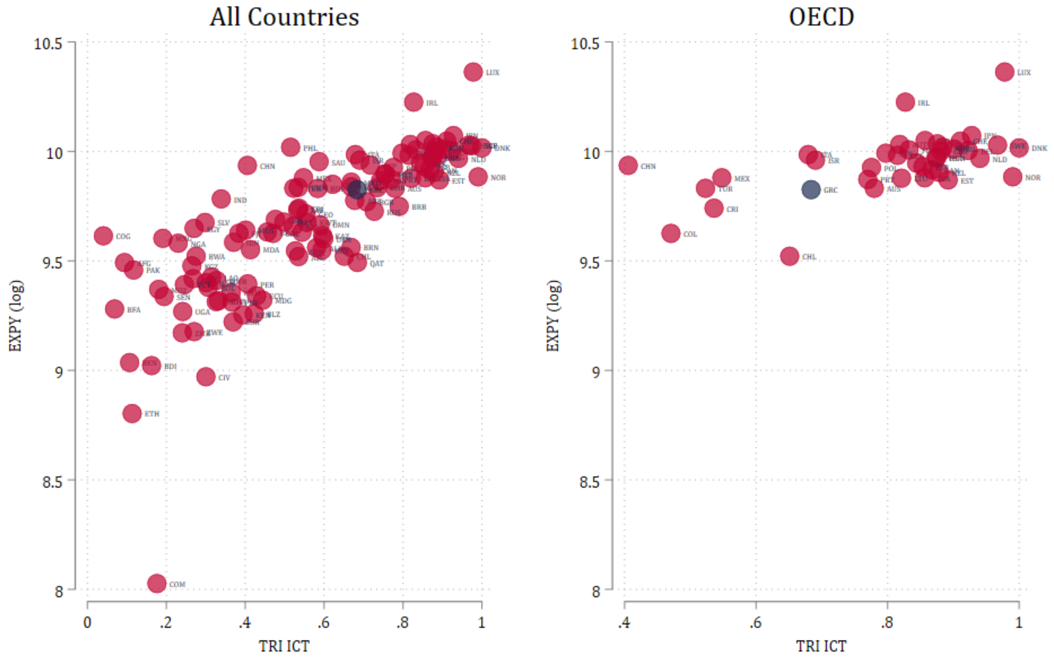

Source: UN COMTRADE and UNCTAD.
Note: The graph shows the normalized revealed comparative advantage following Laursen (2000), for Greece along with the classification of products according to their technological component following Lall (2000). A positive value indicates that the country has a comparative advantage in that product category.

**Chart A4 Greek export basket by complexity**



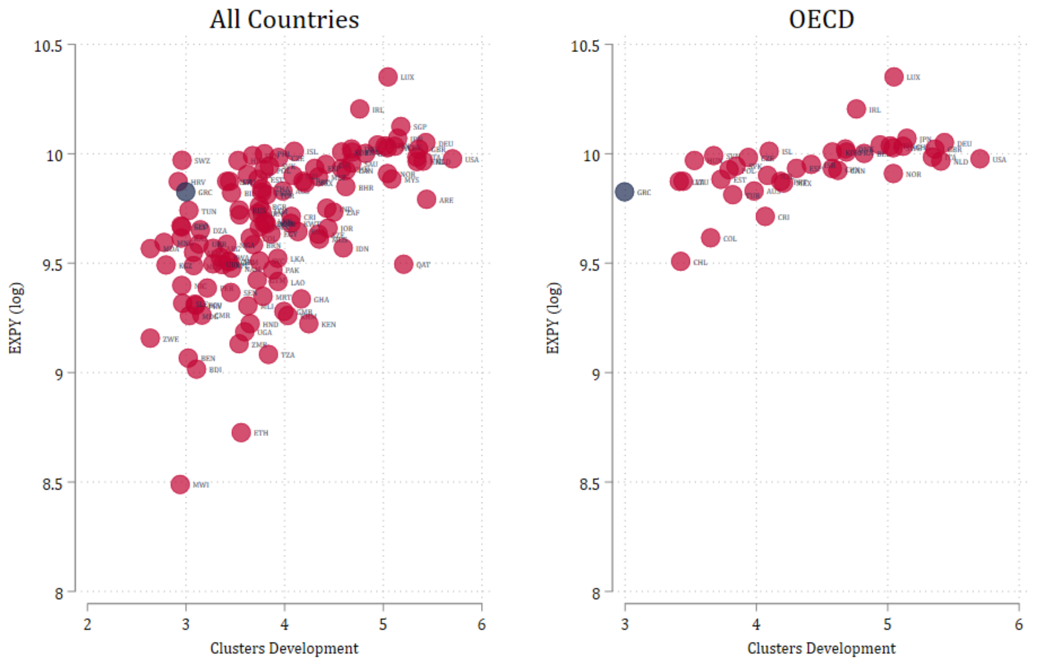

Source: Atlas of Economic Complexity. *(see: The Atlas of Economic Complexity)*

## Chart A5: EXPY and Technology Readiness Index – ICT (2018)




Source: COMTRADE and UNCTAD.

## Chart A6: EXPY and State of Clusters Development (2017)




Source: COMTRADE and World Economic Forum.

## Appendix B: Definitions

The **Economic Complexity Index (ECI)** was developed by Hidalgo and Hausmann (2009). It is calculated in several steps. First, Hidalgo and Hausmann (2009) define the adjacency matrix $M_{cp}$ with its elements taking the value of 1 if country c has an RCA>1 in product p and 0 otherwise. Country diversification is then calculated as $k_{c,0} = \sum_p M_{cp}$, while product ubiquity is calculated as $k_{p,0} = \sum_c M_{cp}$.

The average ubiquity of products exported by country c is calculated as $k_{c,1} = \frac{1}{M_c} \sum_p M_{cp} k_{p,0}$, while the average diversification of a product's p exporters is calculated as $k_{p,1} = \frac{1}{M_c} \sum_c M_{cp} k_{c,0}$.

The ECI formula is the solution to the system of the two above equations and ECI is normalized as follows:

$$ECI = \frac{k_{c,1} - \overline{k_{c,1}}}{SE(k_{c,1})}$$

For the **extensive margin of exports**, we use the measure developed by Hummels and Klenow (2005). It is a weighted average of products exported by country j to country $m$ over total world exports to country $m$. The aggregate margin is the average of the margins across all countries. While Hummels and Klenow weigh countries by their export share, we use an unweighted measure, which is more meaningful as a true measure of the extensive margin, as it does not give special weight to existing trading partners. A pure category measure (i.e., the sum of positive product-destination pairs) gives similar results.

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